Geographical Simulation Analysis for Logistics Enhancement in Asia

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Abstract

This paper simulates the reduction of several components in trade cost for Asia. Our simulation model based on the NEG includes seven sectors, including manufacturing and non-manufacturing sectors, and 1,654 regions of 13 countries in Asia. In addition, the currently available routes of highways, railways, sea shipment, and air shipment are incorporated in our model. The course of transactions among regions is modeled as determined by firms’ modal choice; firms choose the course with the lowest trade costs. The model also includes the estimates of some border cost measures such as tariff rates, non-tariff barriers, other border clearance costs, transshipment costs, and so on. In short, our simulation model is a comprehensive one for examining the impacts of broadly-defined trade costs. Our simulation analysis for Asia contributes to illustrating more clearly the powerfulness of the NEG in the CGE analysis on the trade cost reduction. It includes several scenarios of the improvement/development of routes and the reduction of the above-mentioned border cost.

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1 Introduction

New economic geography (NEG) is a powerful tool for exploring the impacts of the reduction in trade/transport cost on industrial distribution. Several studies have applied the mechanics of NEG into the computable general equilibrium (CGE) model in order to investigate such impacts, mostly for Europe, where the trade cost has already been low. Compared to Europe and North American countries, Asian countries are characterized by relatively high trade costs and transportation costs. Unlike the case of Europe, even basic infrastructures such as well-paved roads have been less developed in many Asian countries, and even in one country there exist huge gaps in quality of the infrastructures. In those countries, various kinds of border cost such as tariff and non-tariff barriers have also remained at a high level. Thus, besides physical infrastructure improvement, our simulation analyses show that the reduction of various kinds of trade cost leads to the drastic change of industrial distribution in Asia. Such situations are clearly explained by NEG models.

Our simulation model based on the NEG includes seven sectors, including manufacturing and non-manufacturing sectors, and 1,654 regions of 13 countries in Asia. In addition, the currently available routes of highways, railways, sea shipment, and air shipment are incorporated in our model. The route of transactions among regions is determined by firms’ modal choice with reflecting the type of goods; firms choose the course with the lowest trade costs. The model also includes the estimates of some border cost measures such as tariff rates, non-tariff barriers, other border clearance costs, transshipment costs, and so on. Thus our simulation model is a comprehensive one for examining the impacts of broadly-defined trade costs.

Our simulation analysis for Asia contributes to illustrating more clearly the powerfulness of the NEG in CGE analysis on the trade cost reduction. It includes several scenarios of the improvement/development of routes and the reduction of the above-mentioned border cost, which are listed in Comprehensive Asia Development Plan (CADP) by ASEAN secretariat.

Simulation results show that each infrastructure improvement always results in positively influenced regions and the others due to the connectivity to the target infrastructure. We also show that in non-physical improvements also contribute higher economic growth. Moreover, we find that physical and non-physical improvements together contribute larger than the sum of contribution conducted independently by each. In short, it becomes possible to obtain much clearer pictures on the impacts of trade cost reduction on industrial distribution in the case of Asia than that of Europe.

The rest of this paper is organized as follows; in section 2, current economic integration in Asian countries is summarized. In section 3, the model and data of the simulation is presented. In section 4, simulation results are discussed. Possible caveats and future extensions are discussed in the final section.
2 Economic integration and simulation

Forslid, Haaland, Knarvik and Maestad (2002) and Forslid, Haaland and Midelfart-Knarvik (2002) employ theoretically similar setup and analyze the impact of falling trade costs in EU regions. When trade costs continuously decrease, using the CGE model with intra- and inter-industry linkage, Forslid, Haaland, Knarvik and Maestad (2002) find that an (inverted) U-shaped pattern of agglomeration is observed in industries which have significantly increasing returns to scale and intra-industry linkage. They also find that other industries exhibits monotonous increases in concentration. Moreover, they find the U-shaped pattern of agglomeration at the aggregate level of manufacturing. Using the same model, Forslid, Haaland and Midelfart-Knarvik (2002) examine the enlargement of the Eastern region of the EU, and find different consequences among regions. As is pointed out by Bosker, Brakman, Garretsen and Schramm (2010), which should be noted, is that some of the properties in the complex setup for CGEs with their sets of assumptions, are not exactly known, and the structural parameters of such analysis are often quite difficult to be estimated. These studies would most likely result similarly to our analysis. In particular, we show some of the results such as concentration of industries and unbalanced growth. These come from the theoretical predictions of the original model based on increasing returns.

Francois and Wignaraja (2008) analyze the economic impact of Asian economic integration such as: ASEAN+3, ASEAN+3+India, ASEAN+3+South Asia FTA. When we focus on Asian Economic Integration, including Francois and Wignaraja (2008), there are several papers in CGE/GTAP that are based on different methodologies; Siriwardana (2003), Urata and Kiyota (2005), Plummer and Wignaraja (2006). Since concentration of industries and population are two of the prominent phenomena, in order to explain such situations, the basis of increasing returns and the mechanism of agglomeration are indispensable.

3 Model and Data

Our simulation model is used to determine twelve values of the following regional variables, nominal wage rates in three sectors, land rent, regional income, regional expenditure on manufactured goods, price index of manufactured goods and of services, average real wage rates in three sectors, population share of a location in a country and population shares of a sector in three industries within one location.

Our model allows mobility of workers within each country and between sectors. There are agriculture, five manufacturing and service sectors. The schematic description of the model is found in Figure 1. Theoretical foundation follows Puga and Venables (1996), which capture multi-sector and country general equilibrium of NEG. As is described in the figure, we have incorporated service sector.

The simulation is executed for 25 years. Firstly, with an input data, short-run equilibrium is
obtained and induced migrations are observed. After migration, with the newly resulted distribution of workers and economic activities, next short-run equilibrium is obtained for following year. These computations are iterated. Our simulation employs scenarios based analysis. Each scenario is the development of transport infrastructures. These information are included in the data and updated in each year. Our simulation model is used to determine twelve values of the following regional variables, nominal wage rates in three sectors, land rent, regional income, regional expenditure on manufactured goods, price index of manufactured goods and of services, average real wage rates in three sectors, population share of a location in a country and population shares of a sector in three industries within one location, which are summarized in the following sections.

3.1 Production

Agriculture sector is assumed to be perfect competitive environment and the production is depicted by Cobb-Douglas function of land and labor where the efficiency of production at a region be different. We assume that the transportation costs of agricultural good are set as zero and the nominal wage rate to be the same within a country and between sectors.

Manufacturing sector is assumed to be monopolistically competitive environment and its technology is to be increasing returns to scale, where labor and intermediate inputs of the same sector are required. Intermediate inputs are depicted with using CES function. The price index of in-
termediate inputs reflects all the distribution of the sector. These specifications depict circular
causation which based on agglomeration economies; the more firms are concentrated, the more
workers migrate.\footnote{The simulation model can be extended to include sectoral linkages as in Puga and Venables (1996). However, since we are not sure on the future structural changes among sectors and regions, we restrict our long-term simulation as analyses without sectoral linkage.} Differently from agricultural good, manufacturing products are incurred product
specific-transportation costs, which is modeled in iceberg manner. Firms choose the minimum cost
route of transports from various network connections and several transportation modes, such as
road, ship, train and air. The model also includes the estimates of some border cost measures such
as tariff rates, non-tariff barriers, other border clearance costs, transshipment costs, and so on.
Thus our simulation model is a comprehensive one for examining the impacts of broadly-defined
trade costs.

Service sector is characterized increasing returns to scale technology with labor input only.
Similarly to manufactured goods, service also incurs iceberg-type transportation costs.

3.2 Consumer

Consumers are assumed to possess the same utility function. This implies that expenditure share of
each good is the same among individuals. Regional incomes are depicted by regional GDPs in our
simulations\footnote{Governmental expenditure and tax are not included in this setup but can be added.}. Land rent from agricultural sector is captured in the regional income of the region
where the land locates.

3.3 Migration dynamics

Migration decision of workers is characterized by real wage differences. In the same region, price
index is assumed to be identical. When there is a nominal wage difference among sectors, workers
in lower wage sector move to higher wage sector. Among regions, price indexes are different. When
there is real wage difference among regions, workers are assumed to move the region of higher real
wage. Such movement of workers ensures the wage equalization among sectors. Among region,
there is a difference in migration dynamics. Since each worker conceives real wage which reflects
price index and nominal wage rate, when there is a region of higher real wage, some workers can
enjoy higher real wage with moving there. As long as there is a real wage difference between any
two regions, there is migration between regions.

3.4 Data

The data of our simulation covers 13 countries and 1654 regions. Based on mainly official statistics,
we derive Regional GDP (GRDP) of agriculture, five manufacturing and service sectors. Five man-
ufacturing sectors are agricultural and food processing, garment and textile, electronics, automotive
and other manufacturing. The year of data is around 2005. In order to capture the geographical
spread of population and economic activities, the following figures show population density and GDP density which is GDP per square km.

4 Simulation results

We set a baseline scenario as a case without any infrastructure improvement and trade facilitation among nations. There are two obvious factors; population and economic growth. Besides population shrinkage, there are many regions which exhibit higher GRDP.

Figure 4 and 5 are the estimated result for baseline scenario. Comparison with the baseline scenario, we compute changes in GRDP as of 2030. There are 6 scenarios; MIEC (Mekong-India Economic Corridor), EWEC (East-West Economic Corridor), NSEC (North to South Economic
Corridor), IMT+ (Indonesian connectivity), BIMP+ (Philippine-Indonesian connectivity), SKRL (Singapore-Kunming Railway Link). Each scenario is an international/intrational development plan of ASEAN countries and the simulation results are shown in Figure 6-11.

In Figure 12, combined simulation of all scenarios is shown. It was found that physical infrastructure improvement always leads the affected and non-affected regions. While the formers are benefited, the latters are left behind. Thus, in order to mitigate the welfare loss and gaps, keeping the effectiveness of each project, enhancement of the complementarity among the projects would

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3There are one highway and two sea routes to be developed. The highway, on which vehicles can run at 60 km/h, starts at Bandar Ache and goes through the eastern part of Sumatra Island and ends in Jakarta. At the Sunda Strait, Bakaheuni and Merak are assumed to be connected by a bridge. Two sea routes, Port Belawan-Port Penang and Port Dumai-Port Malacca, are connected at the speed of 14.7 km/h, on par with other internationally important routes. The time cost is reduced to two hours, and monetary costs are reduced to USD 100.

4The land routes of Jakarta-Surabaya, and Manila-Davao are upgraded, *meaning cars can run on it at 60 km/h. Additionally, the sea routes of Manila-Singapore-Jakarta in Indonesia and Davao-Manado-Balikpapan-Surabaya in the Philippines are also upgraded, meaning the speed is doubled and border costs (time and money) are reduced to the half of the baseline scenario.
be suggested. Besides the physical infrastructure improvement, in Figure 13 it is shown that trade facilitation of non-tariff barriers, such as custom procedures, policy differences and etc., which we call Policy and Cultural Barrier (PCB), could improve the economic growth of all the regions.

5 Conclusion

Our simulation model reveals the future economic geography of Asian. We found that the positive effects of physical transport infrastructure improvements are rather limited to the neighboring regions of the projects. On the other hand we also find that besides the ongoing physical transport infrastructure improvements, further trade facilitation among countries could enhance prevalence of economic growth in each country.
Reference


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Appendix I

Administrative unit is province or state level in Bangladesh, Cambodia, Lao PDR, Myanmar, Malaysia, Singapore, Thailand, and Vietnam. In China and India, the unit is city level. For the details of data construction, see Kumagai et al (2011). Sectoral classifications are harmonized for comparability.