Review of the Potential for Constructing Inter-regional Input-Output Table of Thailand and the Application for Transportation and Logistic Research

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ABSTRACT

The purpose of this paper is to illustrate the significance of constructing the interregional input-output table for analyzing the linkage between regional economies of Thailand. Obviously, Thailand's economy is not homogenous internally, presenting variations across sectors and regions. Thus, the economic impact of economic policies will vary across different regions. Firstly, the history of input-output table development is briefly explained. Then, various kinds of non-survey and partial survey methodologies that have been used to compile the input-output table are overviewed. The potential way and available data that can be used to construct the interregional input-output table for Thailand are subsequently described. Finally, the paper concludes with the recent examples of developments in the construction of an interregional input-output matrix for Thailand and its application to investigate the economic impacts of transportation and logistic investments.

KEYWORDS: Inter-regional input-output, Chenery-Moses model, Interregional trade matrix, Gravity-RAS method

1. Introduction

Economies, whether national or regional, are characterized by a complex network of interdependencies. When an economy of a region is hit by a (positive or negative) shock, it is not strictly an economic agent that is affected, but the entire regional economy. Let us assume a positive shock, such as a new investment project that involves an increase in the "Construction" activity in the region for a certain period. In this case, not only the builders operating in the region arise as beneficiaries. These are involved in the first effect line, but the increase in the construction activity requires an increase in the production of various other materials: cement, metal products, bricks, ceramics of many different kinds; and services: engineering, architecture, etc. Since materials and services consumed by the construction have to be produced, in turn, with other products, this second wave of production may occur in the region, or be satisfied by supply from other places: other regions or countries. Subsequently, the second wave is followed by a third, a fourth, and so on, which can also be met by local or imported production from other regions or countries.

Calculated under the input-output models, the stimuli of the local economy resulting from successive demand increments are usually known as backward linkages. Apart from the inter-industry links described above, a positive shock in one region also generates more income largely distributed to resident households. This increased income allows higher consumption, which must be satisfied with more goods and services that, however, only in part will be produced within the region. Some of these consumer goods will certainly be imported and these imports may be inter-regional or international.

In the language of input-output models, the first type of interdependence, relating the increased demand for raw materials and services as intermediate inputs, equates the indirect effect following the shock that the economy of the region was subject. The second type of effect, which involves the household income growth, corresponds to the induced effect. However, the point is that either the indirect or induced effects following the shock can be felt within the region or go outside regional borders, spreading to other regions or even countries.

For the case of Thailand, an international trade liberalization has a significant impact on its economy. However, the currently available analyzing tools are insufficient to identify those effects at the provincial or even at the regional level. The main reason stems from a lack of appropriate and reliable database linking the economic activities at the regional level.

As claimed by Hulu and Hewings (1993), analysts attempting to build regional or interregional models in developing countries are often confronted by the received wisdom that suggests that the task should be abandoned before it is initiated on two grounds. First, it is claimed that there is little interest in spatial development planning and spatial development issues in general, especially for small size countries. Secondly, the quality and quantity of data are such that the end product is likely to be of dubious value.

Obviously, Thailand's economy is not homogenous internally, presenting variations across sectors and regions. Thus, it is expected that the economic impact of economic policies will vary across different regions. In the context of renewed attention to the spatial aspects of economic development, both from a theoretical perspective (Fujita and Krugman, 2004) and from a policy perspective (World Bank, 2009), there is a growing need for economic and socio-economic models for bringing new insights into the process of regional planning in the country.

There are also government initiatives to promote competition whose ex-ante impacts need to be properly assessed. Both non-spatial (e.g. trade liberalization, TFP-enhancing policies, and sectoral policies) and place-based policies (e.g. investments in infrastructure) are expected to have differential regional impacts, as economic structures of regions vary, and the role of infrastructure and of business and community leaders also vary from region to region. There may also exist important trade-offs between efficiency and regional equity. Understanding the nature of these trade-offs requires to take into account the key linkages between regions using appropriate policy tools. In a context where the public administrations experience a stronger and stronger demand on social policy and security, and where budgets tend to be tightened or even scaled back, the economic evaluation – and optimization – of policy actions becomes a recurrent requirement.

The main goal of this paper is to review the possibility of constructing interregional input-output table that provides a compact and comprehensive accounting framework to quantify the economic interrelationship among industrial sectors and regions within Thailand.

The paper is structured as follows. Section 2 briefly explains the history of input-output table development. The links between input-output analysis and the development of mathematical structure of various accounting scheme are discussed. In section 3, various kinds of non-survey and partial survey methodologies that have been used to compile the input-output table are overviewed. The potential way and available data that can be used to construct the interregional input-output table for Thailand are described in section 4. Finally, section 5 concludes the paper with the possible application of input-output model for transport infrastructure investment appraisal and discusses some remarks on the further development and modification.

2. Input-Output Tables

The input-output model is a model describing the production side behavior of an economic system in which demand and changes in demand create the signals for production to take place. An interesting feature of input-output analysis has been its widespread adoption throughout the world, transcending the distinctions between developed and developing, and between centrally planned, socialist and market economies (Hewings and Jensen, 1987). A variety of modelling structure has been proposed in order to explain the domestic and international effects of any external shock to the economy, such as Isard's (1953) model for a single region and subsequent interregional and multiregional prototypes based on the accounting systems developed by Leontief at the national level.

2.1. The single national or regional accounting system

With the standard Leontief formulation, the accounting balances are described as follows.

$$\sum_j Z_{ij} + FD_i = X_i \tag{1}$$

$$\sum_j Z_{ij} + VA_j = X_j \tag{2}$$

where, Z_{ij} is the flow of intermediate demands between industries, FD_i is the column vector of final demands by consumers, government, industries on investment account, and exports. VA_j is the row vector of primary inputs comprising the various components of value added (wages and salaries, operating surplus, undistributed dividends) and imports. X_i is the total output.

The critical assumption in input-output analysis is that the inputs required to make a unit of output are invariant regardless of the output levels and that the technological production function can be effectively portrayed by converting all flows between industries from physical units into a monetary numeraire. Furthermore, it is assumed that the production function is linear and homogeneous of degree one. Given these conventions, the input coefficient can be defined as follows.

$$a_{ij} = \frac{Z_{ij}}{X_j} \tag{3}$$

Substituting (3) into (1), we have

$$\sum_j a_{ij} X_j + FD_i = X_i \tag{4}$$

which can be written in a matrix form as follows.

$$AX + FD = X \quad \text{or} \quad X = \left(I - A\right)^{-1} FD \tag{5}$$

At the regional level, imports are defined to include interregional as well as international purchases. Therefore, the matrix *A* is decomposed into 2 parts: *R* representing the inter-industry flows within the region and *M* representing the interregional imports necessary to meet the total technological demand in the system. Similarly, the exports are often divided into those within the country (interregional) and those on foreign account. Hence, at the regional level, the closed form solution is:

$$X = \left(I - R\right)^{-1} FD \tag{6}$$

2.2. The interregional input-output accounting system

Similar to a single national or regional IO table, an Inter-Regional IO (IRIO) table can be used to estimate the magnitude of an external “shock” on major macroeconomic indicators such as output, value-added, income and employment. However, unlike its single-region counterpart, an IRIO table is able to capture and assess the inter-regional spillover and feedback effects arising from an exogenous change in demand for the output of any one of the study regions.

The history of interregional models and their closely related derivatives, the multiregional models, has been a strong tradition paralleling the development of national and regional models.

The full interregional model proposed by Isard (1951), in which an n-sector r-region economy is described by technological coefficient a_{ij}^{rs} representing the flows of output from sector i in region r to sector j in region s, has rarely been implemented empirically. The main difficulty with implementation of Isard model is that data on shipments of goods between sectors and between regions are not readily available. Instead, a number of modifications have been proposed.

Chenery (1953) and Moses (1955) proposes the use of trade coefficient t_i^{rs} to reflect the proportion of commodity i which enters region s from region r, Z_i^{rs}, per unit of total intermediate input of i in s, Z_i^s. Namely,

$$t_i^{rs} = \frac{Z_i^{rs}}{Z_i^s} = \frac{Z_i^{rs}}{\sum_r Z_i^{rs}} \tag{7}$$

Let T^{rs} denote the trade coefficient matrix having the following structure.

$$T^{rs} = \begin{bmatrix} t_1^{rs} & 0 & \cdots & 0 \\ 0 & t_2^{rs} & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & t_n^{rs} \end{bmatrix}$$

Finally, for the general many-region case, equation (5) can be modified to the following closed form solution.

$$X = \left(I - TA\right)^{-1} TFD \tag{8}$$

where, $A = \begin{bmatrix} A^1 & 0 & \cdots & 0 \\ 0 & A^2 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & A^n \end{bmatrix}$, $T = \begin{bmatrix} T^{11} & T^{12} & \cdots & T^{1r} \\ T^{21} & T^{22} & \cdots & T^{2r} \\ \vdots & \vdots & \ddots & \vdots \\ T^{r1} & T^{r2} & \cdots & T^{rr} \end{bmatrix}$, $X = \begin{bmatrix} X^1 \\ X^2 \\ \vdots \\ X^r \end{bmatrix}$, and $FD = \begin{bmatrix} FD^1 \\ FD^2 \\ \vdots \\ FD^r \end{bmatrix}$.

Apart from the Chenery-Moses model, Leontief and Strout (1963) employ the concept of supply and demand pools in their development of a gravity version of the interregional model. Riefler and Tiebout (1970) provided a further modification of the Leontief-Strout system and may be regarded as a compromise between the Leontief-Strout and the Isard systems. Within a family of models, the different formulations require varying amounts of data and assumptions concerning the nature of the interregional flows.

3. Literature Review of Methodology

In order to estimate the interregional trade coefficients or commodity flows for developing interregional input-output (IRIO) table, a great deal of work in mathematical approaches has been generated. These methods, both non-survey and partial-survey methods, are often relatively complex. For example, Location Quotient (LQ) techniques, gravity model, RAS method, and others have been developed or applied for such estimation. Lahr (1993) pointed out the importance of the hybrid approach, both survey-based and non-survey, to construct an accurate input-output table with reasonable costs. Definitely, no non-survey or partial-survey technique can be expected to generate a table that is a perfect substitution of what can be obtained if a complete survey were undertaken. Here are some examples of non-survey or partial-survey methods for estimating input-output information.

Yamada (2015) summarizes that LQ techniques are easy to manipulate at least for two regions, though the techniques have the disadvantage that the cross-hauling is inevitably eliminated in the interregional trade. The gravity model, which originally stems from the theory in Physics, is applied to explain the commodity flows among regions, allowing cross-hauling in the interregional trade. The RAS method is originally developed for the estimation of the input output coefficients, for which only the peripheral information of the column-sums and the row-sums is known, in the iterative way. This method requires initial values, on which the solution depends. Ghosh (1973) provides a link between IRIO analysis and linear programming. His major concern is the optimum allocation of industrial establishment among regions in India. Wilson (1970) suggests an entropy approach for the development of interregional input-output model. Using this approach, there is no need to follow a strict specification of the linear programming or gravity-based system. Liew and Liew (1984) provide the compromising methodology by combining the gravity-based approach with the flexibility of Wilson's approach.

Harrigan et al. (1981) estimated IRIO table using the column coefficient and the Chenery-Moses models, and compared it with various techniques such as the Location Quotient (LQ) methods, the Commodity Balance Technique, and the Tibout method. The study concluded that the Chenery-Moses model provides better estimates of inter-regional trade flows than any of the non-survey techniques.

According to Hulu and Hewings (1993), if regionally-specific origin-destination cost data had been available, then it might have been possible to have applied the entropy formulation. In its absence, some prior estimation would have to be applied based on minimum information principle. It is assumed that each region makes a similar proportion of purchases from every other region.

Mizokami (1995) improved the IRIO model by combining the trade coefficient model, behavioral analysis and equilibrium theory. Inamura and Srisurapanon (1997) proposed the interregional rectangular input-output (IRRIO) method to estimate the IRIO which requires the Chenery-Moses model for estimating trade flows. Durand (1998) explained and modeled freight flow according to two spatial distribution methods – gravity model and the structural coefficients method. Sivakumar and Bhat (2002) proposed and applied the fractional split-distribution model for estimating statewide commodity flows or interregional freight flow (IRFF) in Taxes resulting in a model that is better than the gravity model.

While the estimation procedure will be sensitive to the choice of prior estimator, the subsequent RAS adjustments will further modify the initial estimates. The RAS adjustments will not completely override the choice of initial estimator. However, there is little empirical evidence available to justify one initial method over another. Hewings (1977) shows that the RAS adjustment procedure only 'guarantees' accuracy at the margin constraints. While the process yields a unique solution (Bacharach, 1970), this is only true when total intermediate input, output and total output hold constant. Thus, if a different initial interregional coefficient matrix is used, there is no guarantee that the solution of adjustment procedure will be the same.
Bon (1984) demonstrates that the RAS adjustment technique cannot be guaranteed under certain conditions, such as the matrices with few non-zero elements. Mohr et al. (1987) provide a solution to this problem by adapting a linear programming algorithm to the RAS procedure. Given the nature of Thailand economy, it is unclear whether similar problems regarding matrix sparsity will occur with the application of RAS adjustment.

4. Potential for Data Acquisition and Proposed Strategy

4.1. Data Availability

Firstly, the currently available data that can be applied to estimate the inter-regional input-output table for Thailand are briefly introduced. Our proposed methodology on data compilation based on the work of Haddad (2012) is described in the next subsection.

1) National Input Output (IO) table

Thailand has produced benchmark national Input Output (IO) table since 1975, and it has been compiled regularly every five years. Its first IO table is compiled by the office of the National Economic and Social Development Board (NESDB) in cooperation with Chulalongkorn University, the National Statistical Office (NSO), and the Institute of Developing Economies (IDE), Japan. Thailand has also been one of 10 partner countries involved in the periodic compilation of Asia international IO (AIO) table as a continuing project of IDE since it started in the 70's. The latest national IO table is year 2010.

2) Gross Regional Product (GRP)

The National Economic and Social Development Board (NESDB) also collected the gross regional product (GRP) by sector (11 Sectors from1981 to 1995, and 16 Sectors from 1995 to 2009). The GRP Chain Volume Measures Time Series Data are also available during the period 1995-2013.

3) Household Socio-economic Survey 2007

The National Statistical Office (NSO) has collected information every month in all provinces of Thailand and in both municipal and non-municipal areas (January to December 2007). The survey contained important information on social economic aspects of household such as income, expenditures, debt, and income distribution of household.

4) Regional trade allocation pattern

The National Statistical Office (NSO) continuously conducted the “Business Trade and Services Census” and the “Industrial Census” every 10 years, based on the recommendation of the United Nation to obtain timely basic information of the business. The Business Trade and Services Census had been conducted 3 times in 1966, 1988 and 2002. The Industrial Census had been conducted 3 times as well in 1964, 1997 and 2007. However, many key government agencies (Office of Industry Economics, Ministry of Industry, Office of the National Economic and Social Development Board, Bank of Thailand and Ministry of Commerce) require more currently updated information for analyzing and monitoring the economy of the country, in both local and regional area. Thus, NSO decided to conduct the Industrial Census every 5 years starting from 2012 by integrating the process along with the 2012 Census of Business Trade and Services.

The 2012 Business trade and Industrial Census collected basic information that clarify the structure and the distribution of the establishments in economic activity of the country such as wholesale trade, retail trade, services, industry, construction, land transport, storage and information and communication industry and the private hospital activities. The establishments under the scope of this census were those engaged primarily in manufacturing industry classified according to Thailand Standard Industrial Classifications (TSIC-2009).

The collected data that have potential to be used for estimating interregional trade pattern are as follows.

- Values of gross output
- Export
- Total intermediate consumption and value added
- Number of persons engaged and employees
- Remuneration

All of above-mentioned data are those of manufacturing establishments in 2011 by category of industry in 5 regions: (1) Bangkok metropolitan and vicinity, (2) Northern, (3) Northeastern, (4) Central and (5) Southern region.

5) Interregional Freight Flow (IRFF) Data

The origin and destination (OD) tables, also called the IRFF tables, by regions from 1995 to 2007 containing the amount of commodity flows from produced region to consumed region are collected by the Ministry of Transportation. The OD freight data are combined from various sources separated by modes of transportation. Road freight transport data are estimated based on the Land Transport Department 1996 survey data and the yearly commodity production. Rail freight transport data are collected from the State Railway of Thailand. Waterway freight transport data were estimated based on the data from the Marine Department. Air freight transport data were collected from the Thai Airways International.

4.2. Proposed Strategy for Construction of Inter-regional Input-Output Table for Thailand

The main hypotheses and procedures that can be applied to estimate the inter-regional input-output table for Thailand is discussed below under conditions of limited information. As mentioned before, the data of the national accounts (NESDB, 2010) and regional statistics provided by National Statistical Office are available for the estimation.

Step 1: National Accounts

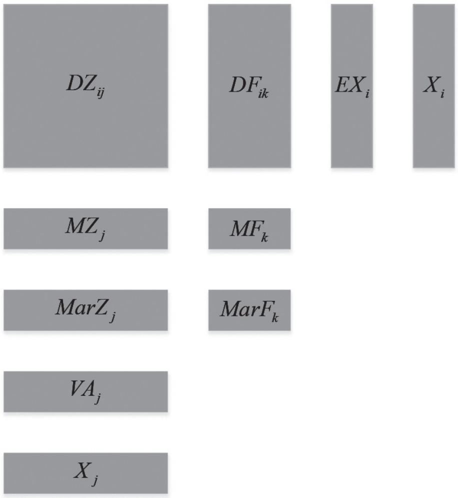

Figure 1: Structure of National Account

The first step is to arrange an input-output matrix for the whole country (see Figure 1) into the suitable format. The main aspect in the treatment of this piece of information is to transform the economic flows, which are valued at market prices, into economic flows valued at basic prices. The procedure adopted in this work is described as follows.

The initial task is to decompose the information on imports and trade margins of each commodity j (MZ_j and $MarZ_j$) and final demands k (MF_k and $MarF_k$) into user-specific format – MZ_{ij} , $MarZ_{ij}$, MF_{ik} and $MarF_{ik}$ (see Figure 2). The initial working hypothesis is that total imports and trade margins are proportional to the share of each user in total demand for the respective commodity. Trade margins on intermediate uses $MarZ_{ij}$ can further be disaggregated proportionally to the specific flows in domestic commodity matrix DZ_{ij} and imported commodity matrix MZ_{ij} (not shown in Figure 2 for simplicity). Similarly, Trade margins on final demands $MarF_{ik}$ can also be divided with respect to the corresponding share of domestic final demands DF_{ik} and imported final demands MF_{ik}. The value-added VA_j and export EX_i can be left untouched. Note that the value of total outputs X_j is fully consistent with the original one in the national account. These procedures generate the input-output national table at basic prices that serves as the basis for compiling the interregional input-output system for Thailand.

Step 2: Regional Accounts

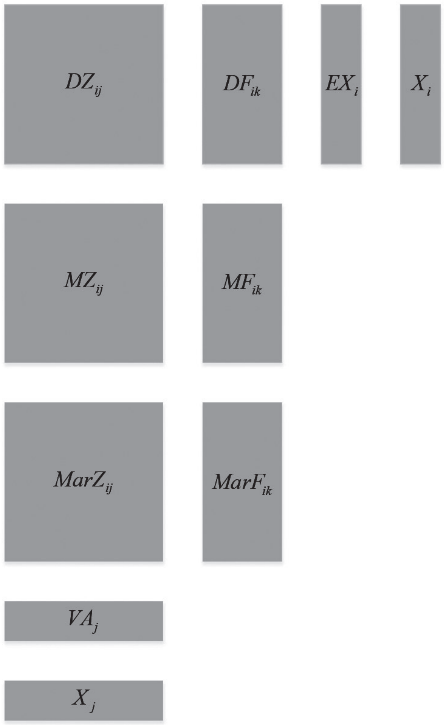

Figure 2: Modified Version of National Account

The next step is to disaggregate the national data into 5 regions of Thailand following the data classification of National Statistical Office (NSO) as previously explained. The strategy used to estimate regional aggregates and regional output by sector is described below.

The gross regional product (*GRP*) is described in equation (9).

$$GRP = C + I + G + (X - M)_{ROW} + (X - M)_{DOM} \tag{9}$$

where C is household consumption, I is investment demand, G is government consumption, $(X\text{-}M)_{ROW}$ is international trade balance and $(X\text{-}M)_{DOW}$ is interregional trade balance.

The regional-level values of household consumption, investment demand and government consumption can be estimated from the specific data source as explained below (see Figure 3).

Household consumption: estimates of individual expenditures from the 2007 Household Socio-economic Survey and total regional population in 2007 are combined to obtain total expenditure by region. Regional shares in total expenditure were used to disaggregate national household consumption from the national account in step 1.

Investment demand: information on regional employment in the construction sector, obtained from the 2012 Business Trade and Industrial Census can be used to disaggregate national investment to the regional levels.

Government consumption : we can use the information on the regional distribution of labor force in trade and services industry (public sector) derived from the 2012 Business Trade and Industrial Census to disaggregate national government consumption.

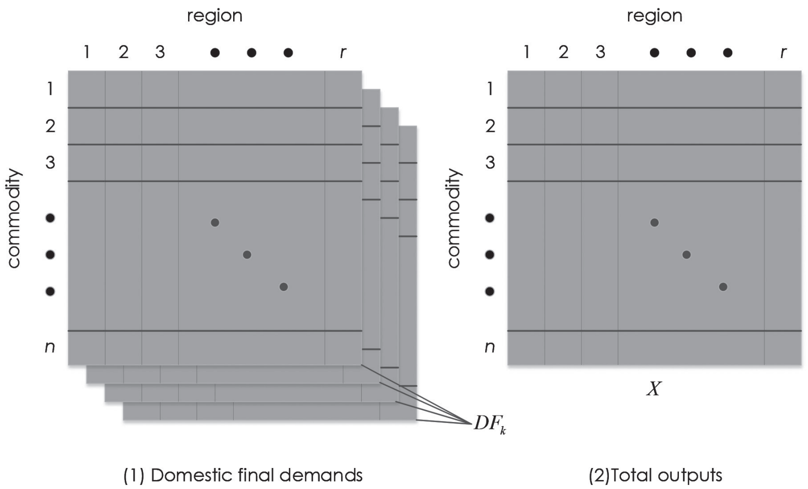

Figure 3: Regional Share of Domestic Final Demands and Total Outputs

The value of international export from each region can be obtained by allocating the national level to producing regions based on their respective **shares in regional gross output.** Further adjustments can be made by considering the relative concentration of sectoral production in each region. For example, we can calculate the location quotients expressing the regional distribution of sectoral employment in comparison to the national level. The value of location quotient greater than one implies that part of its production would be exported to other regions. Therefore, we are able to allocate exports by sector based on the regional allocation of the employment in each sector.

Step 3: Commodity Trade Matrices

In order to regionalize the national IO table, it is reasonable to rely on an adapted version of the Chenery-Moses approach (Chenery, 1953; Moses, 1955), which assumes, in each region, the same commodity mixes for different users (producers, investors, households and government) as those presented in the national input-output tables for Thailand. Trade matrices for each commodity can be estimated and used to disaggregate the origin of each commodity in order to capture the structure of the spatial interaction in the economy. In order words, for a given user, say agriculture sector, the mix of intermediate inputs will be the same as the national pattern in terms of its composition, but it will differ from the regional sources of supply (considering the 5 regions of the model and foreign imports).

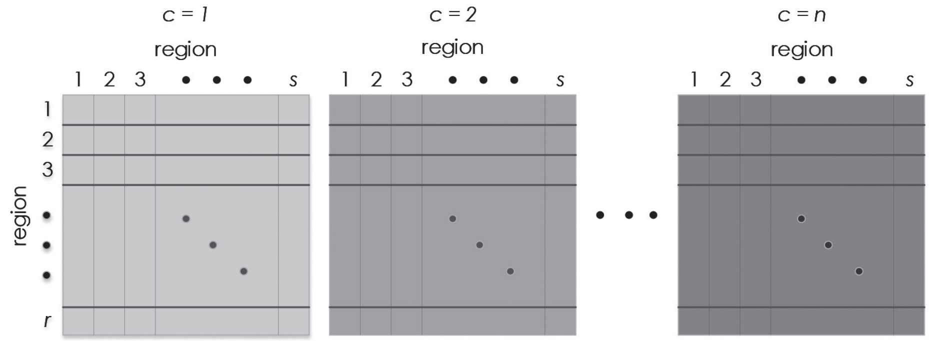

Figure 4: Structure of Trade Matrix

The strategy for estimating interregional trade for each commodity included the following step.

a) Estimate the total supply of each commodity by region excluding international export, by total sale of each commodity for the domestic market (from step 2).
b) Estimate the total demand of each commodity by region by assuming that the structure of demand followed the national pattern. With the regional level of household demand, government demand and investment demand estimated in step 2, we have the initial value of total demand for each commodity in each region, from which the demand for international import must be deducted. Finally, the regional total demand must then be adjusted so that demand across regions equals supply across region for each commodity.
c) With the information from a) and b), the next step is to estimate the interregional trade matrix representing the transactions of each commodity among regions in Thailand. Following the methodology of Dixon and Rimmer (2004), the procedure is described by equation (10) for the diagonal cells and equation (11) for the off-diagonal elements.

$$\sigma(c,d,d) = \min\left\{\frac{S(c,d)}{D(c,d)},1\right\}F(c) \tag{10}$$

$$\sigma(c,o,d) = \frac{1}{\delta(o,d)} \cdot \frac{S(c,o)}{\sum_k S(c,k)} \frac{1-\sigma(c,d,d)}{\sum_{j\neq d}\left(\frac{1}{\delta(j,d)} \cdot \frac{S(c,j)}{\sum_k S(c,k)}\right)} \tag{11}$$

where c refers to a relevant commodity, o and d represents origin and destination region, respectively. $S(c,d)$ is the total supply of each commodity by region excluding international export. $D(c,d)$ is total demand of each commodity by region without for international import.

$\delta(j,d)$ refers to the distance between two trading regions and can be obtained by considering the highest hierarchy city in the region. The factor $F(c)$ gives the extent of tradability of the given commodity. We typically assume that non-tradables, such as construction, transport and communication and other services, are locally provided goods. The value of 0.9 is then applied for of non-tradables. On the other hand, the value of is set to be 0.5 for tradables, such as agricultural and manufacturing goods.

d) Each column of the matrices in c) describes the share of supply from each region in the specific demand by the region of destination (see Figure 4). The resulting share coefficients can then be multiplied by the demand $D(c,d)$ across the corresponding column of the commodity trade matrices. Finally, the RAS procedure is applied to adjust the matrices to guarantee the balance of supply and demand for each commodity.

To finalize the interregional input-output system, further adjustments should be made to internalize, for example, the information of changes in inventories based on available information.

Using the derived interregional input-output system (see Figure 5), we can continue to evaluate the general structure of the regions. Traditional input-output methods are used in an attempt to reveal similarity and difference in the structure of the regional economies of Thailand.

Let us give the example of interregional linkage analysis that cannot be implemented by other models at national level. By reading along the row of matrices shown in Figure 5, the conventional input-output model is given by the following equations.

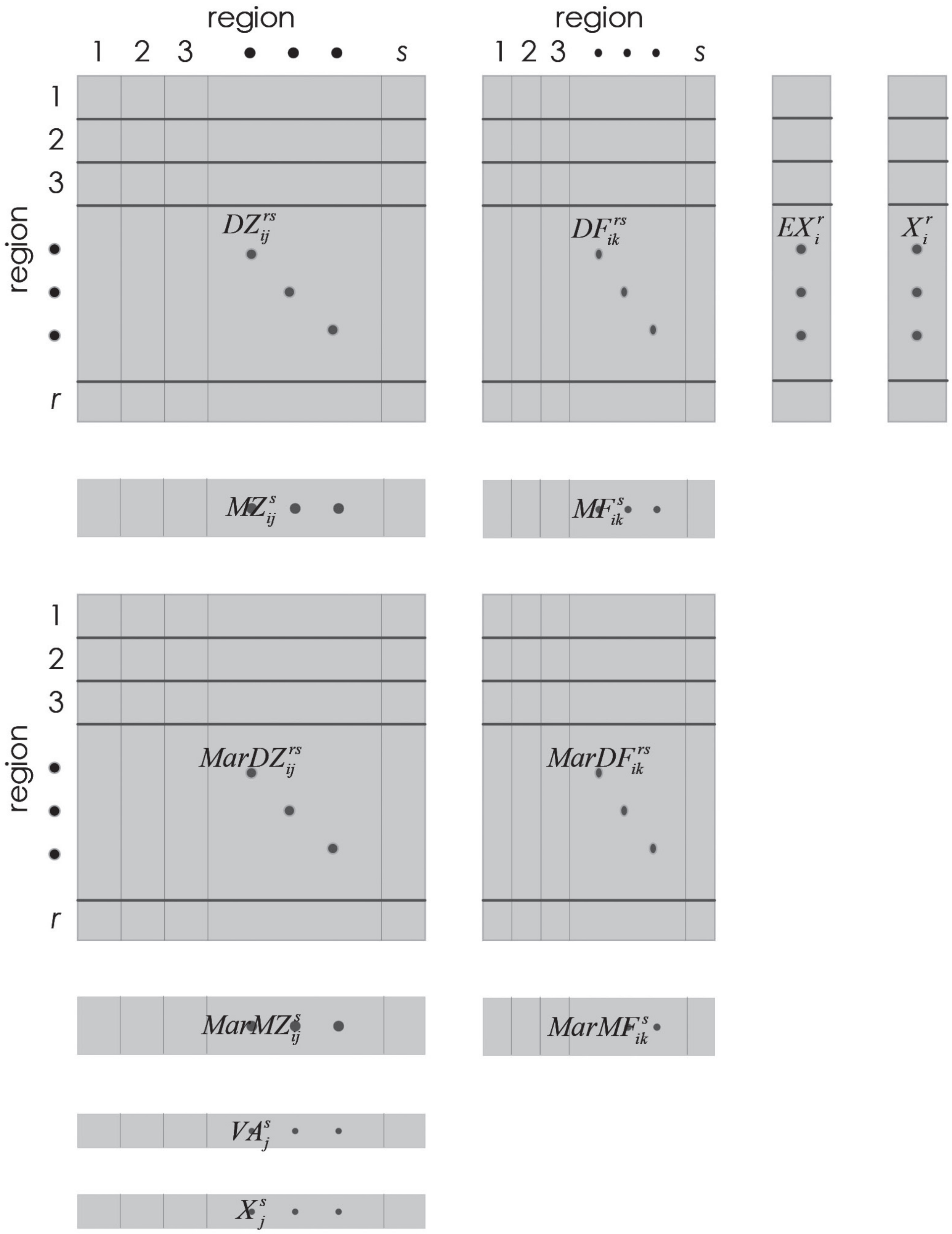

Figure 5: Structure of Interregional Input-Output Table

$$X_i^r = \sum_{j,s} DZ_{ij}^{rs} + \sum_{k,s} DZ_{ik}^{rs} + EX_i^r = \sum_{j,s} a_{ij}^{rs} X_j^s + \left(\sum_{k,s} DZ_{ik}^{rs} + EX_i^r\right) \quad (12)$$

$$X = AX + \left(DZ + EX\right) \quad (13)$$

$$X = (I - A)^{-1}(DZ + EX) = B(DZ + EX) \quad (14)$$

where, the input coefficients a_{ij}^{rs} of the matrix A defined as the amount of product *i* in region r required per unit of product j in region s (in monetary terms and B is known as the Leontief inverse.

In an interregional context, equation (14) can be re-written in the following format.

$$X^r = \sum_s B^{rs} (\sum_r DZ^{rs} + EX^s)$$

Equation (14) also consider different components of final demands and export that originate in the specific regions and abroad. We can then compute the contribution of final demand from different origins on regional output. It is clear from equation (14) that regional output depends on demand originating in the region, on the degree of interregional integration, and also on demand from the foreign region.

Therefore, the interdependence among sectors in different regions can be verified through the analysis of the complete intermediate input portion of the interregional input-output table. The Leontief inverse matrix will be considered, and some summary interpretations of the structure of the economy derived from it can also be provided.

5. Concluding Remarks

5.1. Application of Input-Output Model for Analyzing the Economic Impacts of Transportation and Logistic Investments

The development of effective transport systems, or the improvement of existing ones, typically requires investment of millions or even billions of dollars in public money, even in cases where a proportion of the project's costs are absorbed by the private sector. There has been much discussion, however, over whether such infrastructure investments, when considered on a project-by-project basis, are efficient, or whether public funds would have been better spent on other projects, such as health, energy or water infrastructure. It is clear that, for the investment of public funds to have the greatest positive effects, government agencies need to employ the most suitable ways to assess the economic benefits arising from transport projects. This is obviously necessary so as to ascertain whether these projects sufficiently justify their cost, or whether the funds would be better spent elsewhere, including on competing transport-related projects

An Input-Output (I-O) approach can estimate both macro-economic changes and industry-specific changes (e.g., employment, income, productivity) stemming from the construction, operation and maintenance of a transport system, and/or from business cost savings that the system produces. The I-O approach is also an appropriate method for analysis at disaggregated levels of the economy. The user can further disaggregate the published input-output tables to the level of detail required for analysis.

I-O models can trace the effects of travel cost reductions as they ripple through the regional economy. In this kind of analysis, the input to the model is the dollar value of the travel costs savings (which are derived from estimates of travel time savings, safety benefits, and changes in operating costs) for industries that will benefit from a transport investment. The advantage of the I-O technique is its ease of use and transparency. Another attraction is that the model provides a very detailed picture of the structure of the economy at a particular point of time and makes analysis at disaggregated levels possible. Finally, I-O analysis is politically and ideologically neutral. This is because it does not incorporate any specific behavioral conditions for the individual, companies, or indeed the state.

However, as a methodology for undertaking economic impact analysis, the ease of use comes at a certain cost. In particular, I-O models are easy to use because of a number of limiting assumptions. One major limitation of the model when used to conduct impact analysis is the use of fixed coefficients, which imply that an industrial structure remains unchanged by the economic event. Another major limitation is the lack of supply-side constraints. Constraints on the availability of inputs, such as skilled labor, require some means, e.g., prices, to act as a rationing device so as to induce changes in the consumption patterns of producers and consumers. In I-O analysis, where all adjustments take place in changes in the quantities produced, this type of rationing response is assumed not to occur (West, 1995). Nevertheless, because of its comprehensive but easy-to-understand description of complex economic systems, the I-O method has been one of the major statistical tools for most economically important countries in the world over many years.

Although the I-O model is a good research methodology to explore the influence of transportation on the other sectors, there have been few studies that apply the I-O model directly for analyzing the transportation or logistic investments. Some of these rare studies are discussed below.

Kwak et al. (2005) employed comprehensive I-O models, including inter-industry linkage effect analysis, the demand-driven model, the supply-driven model, and the Leontief price model, to investigate the role of transportation sectors in the Korean national economy during 1975-1998. The study concluded that the maritime industry in Korea had low forward linkage, supply shortage cost, and price effects, while having high backward linkage, production-inducing, and employment-inducing effects.

Bryan et al. (2006) used the I-O framework to prove that port infrastructure played an important role in supporting other Welsh businesses, requiring government authorities to more carefully consider the value of the port sector for the regional economic development. Instead of conducting a comprehensive analysis, however, the study only estimated the economic effects on employment, incomes and output supported by the ports.

Chiu and Lin (2012) utilize the I-O framework to analyze the essential relationship of inter-industries for efficient production, with the transportation sector as an infrastructure, and to evaluate the impact of a change in the transportation supply investment of the five transportation sectors on the output of all the other sectors in Taiwan, that is, the production-inducing effect. They also used the Leontief price model to assess the price change on the economic system caused by the cost change of the transportation sector by assuming that the cost change of each sector can be completely transferred and the annual production of each sector is given.

5.2. Meeting the Challenges and the Way Forward

Similar to a single-region or national IO table, an Interregional IO table can be used to estimate the magnitude of an external shock on major macroeconomic indicators such as output, value-added, income and employment. However, unlike its single-region or national counterpart, an IRIO table is able to capture and assess the interregional spillover and feedback effects arising from an exogenous change in demand for the output of any concerned region. In other words, constructing an IRIO table will allow us to estimate not only the production increase of a particular region benefiting from, say, an increase in foreign demand for its output, but also the indirect impact on the production level in the other regions arising from the interconnecting nature among regions.

At the present time, not so many works have been devoted to the development of interregional analysis for the case of Thailand. Wongnoppadoldecha and Srisurapanon (2010) compile interregional input-output table based on the Chenery-Moses models and use it as a forecasting tool for interregional freight flow (IRFF). Their IRIO has seven regions—Bangkok and Vicinity, Northern, Northeastern Central, Eastern, Western, and Southern—based on the IRFF data published by the Ministry of Transportation and the gross domestic product (GDP) data announced by the National Economic and Social Development Board (NESDB). However, the original IO table at the national level with180 industry sectors is aggregated into only 2 groups—commodity group and service group.

In order to reveal interregional freight characteristics using available data from the Commodity Flow Survey (CFS), which is the most complete collection of commodity flow data in Thailand, Hirun and Sirisoponsilp (2010) use a flexible Box-Cox functional form together with the maximum likelihood and the backward method to calibrate a provincial origin-destination matrix. Root Mean Square Error (RMSE) and Mean Relative Error (MRE) are used to verify the model’s performance. The results show that the selected variables (origin employment, destination population, destination income per capita and distance) and the Box-Cox functional form are successful in explaining behavior of interregional freight transportation in Thailand.

One of the crucial problems in compiling inter-regional input-output table for Thailand is the discrepancy among data sources. To reflect the economic condition of the whole country and of each specific region, we must reply on the following source of data.

- The National Economic and Social Development Board (www.nesdb.go.th)
  - o All data about real sectors, including the National Accounts, Input-Output tables, Flow-of-Fund accounts.
- Bank of Thailand (www.bot.or.th)
  - o All data about financial sectors, both in domestic transactions and with external transactions, including the balance of payments, capital flow, interest rates, exchange rates.
- Ministry of Finance (www.mof.go.th)
  - o All data about government revenue, expenses, and projects.
- Ministry of Commerce (www.moc.go.th)
  - o All data including Free Trade Agreement, as well as domestic prices.
- National Statistical Office (www.nso.go.th)
  - o Employment, labor forces, others

Combining these data and compiling the consistent input-output is therefore the process that must be handled with care.

The analysis of the economic relationship among regions, such as multiplier, linkage, impact analyses as well as spillover and feedback effects is crucial for a construction of better and more elaborated models in future. The reliability and quality of the results are heavily influenced by the accuracy and precision of the underlying data as well as methods used in compilation. However, the construction of interregional IO table for Thailand will definitely proof to be invaluable for the understanding of functions of the regional economies within an integrated system of Thailand.

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