Spatial Structure and Regional Development in China

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Abstract

During the last two decades, China economy has continually attained high economic growth. As a result, the influences of China on the global economy have been rapidly increased, while the disparity of regional development has become one of the crucial topics for not only academic researchers but also policy planners. In the literature of the studies on regional disparity in China, many researchers have been investigating not only how large this kind of regional disparity is, but also whether it becomes to diverge or converge. But, it should be noted, however, that there are very few studies from the aspect of *Space economy*. More specifically, even if one region is developing with the assumption that the development of other region is still remained, the regional economic system may change, and hence, this change may also give an impact on the economic activity of other regions through the interregional transactions among various industries.

In order to clarify the above-stated regional development problems in China particularly from the spatial aspects, Institute of Developing Economies (IDE), Japan External Trade Organization (JETRO) and State Information Center (SIC) in China, launched in 2001 a joint research project on the compilation on *Interregional Input-Output Model for China*, and this result has published as *Multi-regional Input-Output Model for China 2000* from IDE-JETRO in 2003.

As an application of this input-output model, one year research project was organized in IDE in 2003 to explore the regional development problems from the spatial aspects in collaboration with SIC. Eventually, our research project finally published the book entitled "*Spatial Structure and Regional Development in China: Interregional Input-Output Approach* " in 2004, as IDE Development Perspective Series No. 5, which was edited by N. Okamoto and T. Ihara. This book has the following two aims: one is to pay attentions to the recent spatial structure and regional development in China, and the other is to show how to apply the most beneficial interregional input-output analysis to the various regional problems in China.

Therefore, in this paper, we are to clarify the implications of our empirically derived fact-findings on regional disparity or spatial linkages in China. In addition, we intend to explain the qualifications and limitations of an ordinary input-output model, and we also show how to utilize an interregional input-output approach more effectively from a policy-oriented viewpoint.

1. Qualifications and Limitations of an Input-Output Model

An input-output model has a great advantage as compared with other related models[1], such as an econometric model, gravity-type model, etc. Among others, it should be emphasized that an input-output model has always offered the most fundamental and useful framework so far, which is stemmed from the general equilibrium theory[2]. In addition, an input-output model must be also qualified for easily handling with quantitative measure, although it depends on the following technical assumptions as the *Constant Returns to Scale,* the *Convexity of the Isoquant Surfaces, and* the *Fixed Coefficients of Production.* Therefore, whenever we implement any empirical study by an input-output model, we are always required to check the validity and reliability of those technical assumptions. But, it should be noted, however, that the introduction of such strong technical assumptions into an input-output model naturally assures us to carry out an empirical study with its model. Thus, we are required to recognize the qualifications of an input-output model to the full extent, and hence, to keep on implementing positive practice and empirical studies by actively utilizing an input-output model on one hand. On the other hand, we must cope with the limitations imposed on an input-output model so as to corroborate and develop further an analytical method based on an input-output model.

Methodologically, we can point out, at least, two ways to corroborate a conventional input-output model. One is the way to *deepening*, namely, the *Intensive Development.* The other is the way to *widening*, namely, the *Extensive Development*. More specifically, the former includes such a way as to decompose the conventional Leontief Inverse Matrix, to measure inter-industrial linkages, or interregional feedback effects. The latter includes such a way as to decompose output-growth, to do the shift-share analysis, or to link to other econometric models. Therefore, when we are interested in such interregional issues as income fluctuations, commodity flows, factor mobility, economic planning, etc., then, a derivation from an input-output model at national level to more complicated interregional input-output model becomes inevitable. And, this kind of elaborations of an input-output model might be classified into the former.

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[1] As for various techniques for analyzing regional economies, see Richardson (1978), *Regional Economics,* for example.
[2] General Equilibrium Theory originates in Walras (1892), *Elements d'economie Politiaque pure, ou Theorie de la richesse Sociale*.

Prior to explaining an interregional input-output model, we must clarify some theoretical aspects of an input-output model in general, which is well-known as the relations of *duality*[3]. Due to the above-stated technical assumptions imposed on an input-output model, the product-determining mechanism, is completely independent from the price-determining mechanism in an input-output model, and vice versa. Mathematically, the former mechanism can be specified as $X = [I - A]^{-1} F$, where X and F are vectors of output and final demand, respectively, while the latter mechanism can be specified as $P = [I - A']^{-1} V$, where P and V are vectors of price and value-added, respectively.

If we look back upon the past applications of an input-output model, most of them turn out to be brought about by the former, i.e., the application of the product-determining mechanism. According to this logical reasoning, equilibrium product level can be determined so as to meet the given level of final demand without any capacity constraints. In other words, if we face with some crucial capacity constraints, then, we must take account of this kind of restrictions explicitly at our empirical study. On the other hand, there have been quite few applications of the latter, i.e., the application of the price-determining mechanism. The underlying way of thinking on this mechanism is that the shadow price of each commodity can be determined so as to equalize it to the total costs of inputs. Judging from the recent trend towards the market-oriented economic system in China, how to narrow down the discrepancy between the market price and its related shadow price might be one of the important policy issues, which might be partly resolved by applications of the dual aspect of an input-output model empirically.

In addition, we dare to admit the current circumstances, under which an input-output model has its fans as well as its detractors even now. But, generally speaking, many of the detractors seem to have some qualms or uneasy doubt about the strong restrictions of an input-output model. However, as already stated, many of them stem from assumptions, which were originally introduced by W. W. Leontief in developing a *practical version* of the general equilibrium theory advocated by L. Walras. As a result, we can state that some other practical modeling tools, such as a structural econometric model and also CGE model (i.e.,

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[3] See Leontief (1986), *Input-Output Economics,* or Dorfman, Samuelson and Solow (1958), *Linear Programming and Economic Analysis*, for example..

the Computable General Equilibrium Model)[4], etc. have gradually emerged over time. Therefore, we can circumnavigate a discussion of our take on the pros and cons of the alternatives. Nonetheless, at this stage, we must admit that an input-output technique is not complete, yet, without some discussion of these alternatives. But, we should not overlook the fact that an input-output model is still characterized as a powerful *practical version* of the general equilibrium theory, whose advantage lies in its stress on mutual *interdependence*, which shows how "everything depends upon everything else" quantitatively.

2. Important Issues on Interregional Input-Output Model

As one of the *Intensive Development* of an input-output model, we can readily extend it to the regional level, since it covers the range between extreme aggregation and complete disaggregation. If we need to clarify the regional differential or interregional linkages more in details, an input-output table at the national level should be further disaggregated to the regional level so as to measure the interregional feedback effect.

Formally speaking, various types of an interregional input-output model have been proposed and empirically applied so far for different aims. Among others, the Isard-type model is the most primitive and fundamental one[5]. In this model, an *interregional input coefficients, i.e.,* a_{ij}^{rs} in A is directly defined for any sector i in region r, and any sector j in region s, respectively. Therefore, a_{ij}^{rs} in A stands for an interregional input coefficient of sector i in region r in order to produce one unit of output of sector j in region s (i, j = 1,2,･･･,n: r, s = 1,2,･･･,m). As a result, the Isard-type model requires a detail information of interregional transactions not only for supply side but also demand side sectors. Thus, from the practical point of view, we are required to examine very carefully the stability as well as reliability of those interregional input coefficients.

Another operational interregional input-output model has been proposed as a modification of the above-stated Isard-type model, which is called the Chenery-Moses-type model[6]. The relative advantage of this model lies in separating the input coefficients (i.e., a_{ij}^{s}), from the trade coefficients (i.e., t_i^{rs}). The former (i.e., a_{ij}^{s}) means the total inputs from sector i in order to produce one unit of output of sector j in region s, while the latter (i.e., t_i^{rs}) means the total amount of purchases

[4] See reviews by Shoven and Whalley(1984), (1992).
[5] See Isard (1951), Interregional Input-Output Analysis: a Model of a Space Economy.
[6] See Chenery (1954), Interregional and International Input-Output Analysis, and also Moses (1955), The Stability of Interregional Trading Patterns.

from sector i in region r by region s. Mathematically, the relations between those coefficients in two different type models can be specified as follows:

$t_i^{rs} \cdot a_{ij}^{s} = a_{ij}^{rs}$; i, j = 1,2,･･･,n: r, s= 1,2,･･･,m

where t_i^{rs} is the total amount of purchases from sector i in region r by region s,

a_{ij}^{s} is the total inputs from sector i in order to produce one unit of output of sector j in region s,

a_{ij}^{rs} is the interregional input coefficient of sector i in region r in order to produce one unit of output of sector j in region s.

Therefore, so long as we stick to the Chenery-Moses-type model in our empirical implementation, we can readily carry out the impact studies so as to measure the different effects of the changes in production techniques and the changes in trading patterns, separately.

The last but not least interregional input-output model has been proposed by Leontief, which is called the Balanced Regional model[7]. It differs from the former two-type models by classifying the goods under study into three categories, i.e., national goods, regional goods and local goods, respectively. The basic mathematical structure of this model is identical to that of the above-stated interregional input-output model, but the interpretation of each of the pieces of the model is rather different. It should be noted that the entire analytical structure of this model is based on the observation that in any national economy there are goods with different kinds of market areas. More specifically, there are some goods for which production and consumption balance at the national level. These are goods that have essentially a national market area. On the other hand, there are other sectors for which production and consumption tend to balance at a lower geographical level, i.e., which serve a regional or local rather than a national market. Therefore, we can easily point out the fact that there is an entire spectrum of possibilities, from sectors that serve extremely small local market to large national and international markets. This is the main reason why market-oriented goods-classification (or the three-type industrial classification) has been done explicitly in the Balanced Regional model.

Then, keeping those interregional input-output models in our minds, let us refer

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[7] See Leontief, W. (1965), The Economic Impact - Industrial and Regional - of an Arms Cut, Review of Economics and Statistics, Vol. 47, No. 3.

to some important remarks, which should be taken into account prior to various empirical implementations. The most important issue is how to define regions precisely, which conform to the interregional input-output model. Naturally, the delimitation of region is not an easy task. No matter how we use economic, administrative, historical or other criteria, there are no satisfactory methodologies, yet. Therefore, a certain compromise becomes inevitable.

Be that as it may, there are a few safe generalization in defining regions. There is, of course, no unique definition, and hence, as a result, the choice must depend, to a large degree, upon the objectives of our inquiry or subject of interest. For example, if regions are needed as a means of disaggregating national plans into interregional planning, then a small number of regions (perhaps six to fifteen) seems to be appropriate. In this case, the contiguity criterion becomes very important[8]. In other words, the regions of the system under study must not overlap, and combined they must exhaust the national territory. Therefore, an interregional system simply means the carving up of a national space into a limited number of adjacent regions. Incidentally, it should be noted that in multi-regional input-output model for China 2000, eight regions[9] are defined based upon our careful considerations of real economic situations in China.

In addition, we must also take into account of the fact that the difference between regions and nations has important implications for the content of regional economic analysis. Clearly, a region cannot be treated as a closed system, for *openness* is its essence. As a result, the key property of regional economies is their degree of *openness*. The assumption of a closed economy seems to be common to many macroeconomic models of the national economy, and hence these models cannot be used, unless they are drastically modified, for analyzing sub-national regions. Therefore, so long as regions are open systems, key exogenous variables must be specified more carefully. Furthermore, the greater possibility of *disequilibrating* process must be recognized, and then the models should be less deterministic, and also regional economic projections accepted to be more uncertain.

The third, and also very important, remarks on utilizing an interregional input-output analysis tell us to make clear distinctions between *intra-regional* and *inter-regional* economic activities, or transactions. In a multi-regional setting of an

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[8] See Richardson (1978), *Regional Economics*, for example.

[9] Eight regions to be defined are as follows: *Northeast, North Municipalities, North Coast, East Coast, South Coast, Central, Northwest and Southwest*, respectively.

input-output table, the former can be shown by diagonal sub-matrix of a certain region, while the latter can be shown by off-diagonal sub-matrices of any two different regions. Therefore, if we are interested in formations of economic clusters or urban agglomerations, then, we must pay more attentions to the former sub-matrices and examine them quantitatively. On the other hand, if we are more interested in the regional autonomy or the degree of openness of a particular region, then, we must pay more attentions to the latter sub-matrices and try to measure the interregional feedback effects or the degree of spatial linkages. But, when we deal with the latter sub-matrices, i.e., interregional trade flows, we are often likely to face the cross-hauling phenomena, which might be ascribable to the way of aggregations. Thus, for utilizing interregional input-output analysis, we are highly required to check this kind of aggregation problem to the full extent.

3. Fact-findings and Interpretations from our Study Works

Based upon our Interregional Input-Output Table for China 2000 (Institute of Developing Economies, 2003), which was partly estimated by the above-stated Chenery-Moses-type model, we have already analyzed various regional development problems in China. Some important fact-findings and interpretations from our empirical study works are summarized as follows:

- A great difference among regions in the scale of territory, the size of population and the degree of richness, has been clarified.
- East Coast region has the strongest economic power and also has the most promising market potentials.
- Coastal region has been developed by the final demand factors, with its comparative advantage of construction and agricultural sectors.
- Natural resource allocation across the regions in China also might affect the different development performance.
- A particular spatial linkage in China has been formed.
- Coal, oil, natural gas, metal ore and agricultural resources tend to flow from Central and Western regions to East Coast and South Coast, while manufacturing products tend to flow from Coastal region to Central and Western regions.

Keeping those fact-findings in our minds, what can we say confidently from our empirical study works on the whole? Then, we might at least point out the following two descriptions:

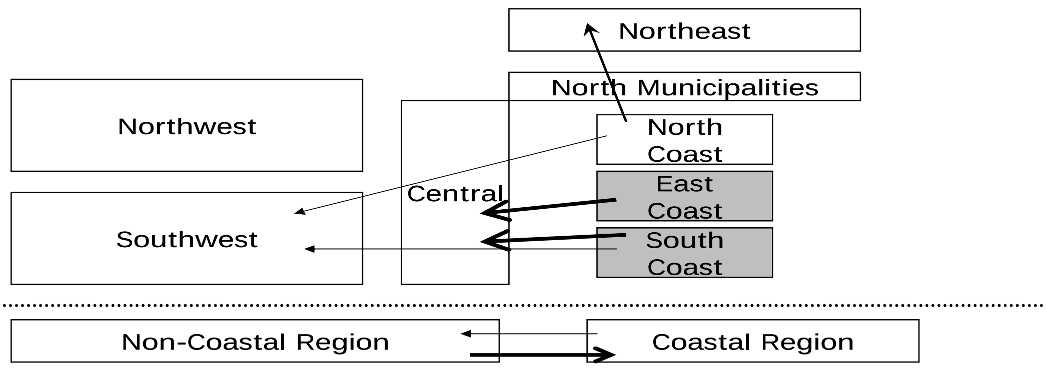
1) Northeast region, which is considered as heavy industrial areas, has a sort of

self-sufficient structure with relatively few spatial linkages to other regions. On the other hand, East Coast and South Coast are regarded as the development center or growth pole, in which industry is highly concentrated, and their economic activity has a certain amount of spillover effects on Central and Southwest. Central and North Coast might stand the economic position as the suppliers of materials and intermediate goods, to support the development of Coastal regions. However, Northwest is considerably dependent on other regions.

2) From the viewpoint of regional development policy, it is highly important to consider the spatial interactions among different regions. Judging from our fact-findings, we may conclude, as some policy-implications, that Northeast should form more intensive spatial linkages with North Coast and North Municipalities, while Northwest should introduce more investments of new industry into the associated region.

Diagrammatically, spatial structure in China can be shown as follows:

Spatial Structure in China



In addition, let us refer to the statistical measures and their empirical results, respectively.

- *Backward* Linkages measure the dependence of one sector on other sectors who provide intermediate inputs as a material supplier.
- *Forward* Linkages measure the effect of the changes of other sectors output values, induced by the change of the output value of one sector as a supplier.

- *Direct* Backward Linkages mean the summation over all sectors of one column of the input coefficient matrix, and hence capture the total value of intermediate inputs by one sector in producing one unit of its output.

- *Total* Backward Linkages mean the summation over all sectors of one column of the_Leontief inverse, and hence capture the output of all sectors that would increase as a result of a one-unit increase in final demand for one sector.

- *Direct* Forward Linkages mean the row sum of the output coefficient matrix, and hence measure the percentage of one sector's gross output that is sold to all sectors as intermediate input.
- *Total* Forward Linkages mean the summation over all sectors of one row of the Ghosh inverse, and hence capture the output of all sectors that would increase as a result of a one-unit increase in the value-added for one sector.

- *Direct* Backward Linkages:
  →East Coast (0.70), South Coast (0.67), North Municipalities (0.66), Northeast (0.65), North Coast (0.64), Central (0.62), Northwest (0.58), Southwest (0.58)
- *Total* Backward Linkages:
  →East Coast (2.68), Northeast (2.64), North Coast (2.54), Central (2.51), North Municipalities (2.46), Northwest (2.35), Southwest (2.30), South Coast (2.30)

- *Direct* Forward Linkages:
  →North Coast (0.71), Central (0.68), East Coast (0.67), North Municipalities (0.66), South Coast (0.63) , Northeast (0.62), Southwest (0.56), Northwest (0.56)
- *Total* Forward Linkages:
  →North Coast (3.24), East Coast (2.98), Central (2.98), North Municipalities (2.90), South Coast (2.75) , Northeast (2.71), Northwest (2.46), Southwest (2.32),

4. Spatial Linkages in China and Some Concluding Remarks

So far, we explained the possibility of making use of full-scale interregional input-output table in China for the year of 2000, which has been released by the Institute of Developing Economies, JETRO, in March 2003. As a result, we can also depict the following spatial linkages in China in a compact way by comparing *direct* backward linkages with their *direct* forward linkages as well as comparing *total* backward linkages with their *total* forward linkages, respectively.

Spatial Linkage in China (1)

Direct Forward Linkage		Direct Backward Linkage: Low	Direct Backward Linkage: High
	Low	Northeast North Municipalities Southwest	East Coast South Coast
	High	North Coast Central	Northwest

Spatial Linkage in China (2)

Total Forward Linkage		Total Backward Linkage: Low	Total Backward Linkage: High
	Low	Northeast Southwest	North Municipalities East Coast South Coast
	High	North Coast Central	Northwest

It should be noted that an agglomeration is a cumulative process of geographical concentration of industries while a linkage measures the mutual dependence of one sector or region on other sector or region. But, in investigating the mechanism of such an agglomeration, we must consider the world where increasing returns and transport costs works, but forward and backward linkage are both important because they can create a circular logic of agglomeration.

Lastly, let us refer to some concluding remarks on this paper. We can readily brush up our own analytical skill on input-output model and even further cut a new frontier on more sophisticated interregional input-output analysis for China. But, in order to do so, we are highly required to understand the *qualifications* and *limitations* of the basic input-output model to the full extent. Therefore, we have clarified the relative advantage of an input-output model so as to consider some policy implications in applying its model to more complicated spatial settings.

For further research works, let us summarize the contemporary frontiers on an input-output model. Firstly, how to analyze the structure of production over time and across regions has been still a focus of an input-output model. In order to find out the key sectors in an input-output model, the use of hypothetical extraction method [10] or the use of fields of influence [11] have been proposed on an *Inter-industrial Linkages*.

Secondary, how to measure the spatial interdependencies in an input-output model is another important task on *Spatial Structural Analysis.* Miller's work, for example, has the profound implications for studying regional economy, since he demonstrated the fact that interregional feedback effects are generally quite small, thus admitting the use of strictly intraregional models as opposed to multi-regional specifications[12].

Thirdly, the *Decomposition Techniques* have been also developed remarkably. The most commonly applied approach today is known as a structural decomposition. The central idea behind it may be ascribable to the fact that change in an economic variable can be decomposed, commonly in an additive fashion, into changes into the constituent parts of this variable[13].

Keeping those fundamental properties of an input-output model so far, we are strongly looking forwards to making more researchers as well as practitioners feel attractive and fascinating by utilizing the path breaking input-output analysis in China.

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[10] See Cella (1984), for example.
[11] See Hewings, *et al.*(1989), for example.
[12] See Miller (1966), and also see Ihara (1999), for example.
[13] See Lin and Polenske (1995),for example.

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