地域間産業連関表の作成と活用：中部地域におけるケーススタディ

当財団では、「中部広域経済圏を対象とした経済分析ツールの開発と応用研究」を推進するため、2010年５月に「経済分析・応用チーム」を発足させました。

現在は、各県が個別に公表している産業連関表を物流センサス等の統計データを使って連結し、中部広域９県版地域間産業連関表の作成を進めております。今回は2010年９月12日に行ないました、北京大学（中華人民共和国）での講演内容を報告いたします。

財団法人中部産業・地域活性化センター　経済分析・応用チーム
井原健雄、野崎道哉、ティティポンタラグン ノンタチャイ

2010年９月11日（土）～12日（日）、日本と中国、およびアジア諸国における地域科学の研究交流を促進するため、応用地域学会（ARSC：The Applied Regional Science Conference）と中国地域学会（RSAC：Regional Science Association of China）の協同により、北京大学で第１回アジア地域科学セミナーが開催された。セミナーでは、地域科学に関わる諸課題について、工学、都市計画、経済学、地理学、環境科学など学際的分野の報告が行われた。具体的には、地域環境の持続可能性、アジアの地域・都市問題、空間経済学と経済地理学、低炭素社会とアジア地域の経済発展など、広範なテーマで報告が行われ、それぞれのセッションで活発な意見交換がなされた。

今回、CIRACの経済分析・応用チームの野崎とティティポンタラグンも本セミナーに参加し、“**How to Compile and Utilize *an Interregional* Input-Output Table－A Case Study of *Chubu* region in Japan－**”と題し、中部圏地域間産業連関表の作成とその活用について研究報告を行った。

本稿は、第１回アジア地域科学セミナーでの研究報告について、加筆・修正のうえ、論文にまとめたものである。

要旨：本稿では、中部圏を対象とした「地域間産業連関表」の作成とその活用に関するその作業過程で顕在化した経験的事実に基づき、基礎的な吟味検証を試みるとともに、当該地域における各種プロジェクトの経済波及効果の計量的把握や、地域政策の提言等に寄与すべき分析ツールの整備とその開発の意義を明らかにしようとするものである。

本稿の内容を要約すると以下のようになる。

第１節では、本稿の目的、中部地域における地域間産業連関表作成の背景について述べている。中部地域は、日本の中心に位置する開放性と多様性を持つ地域であり、整備の進んだ交通インフラにより隣接する地域と密接に連結されている。

第２節では、中部地域を対象とした地域間産業連関表の作成と活用を行う理由が明らかにされる。今回の中部圏地域間産業連関表における地域区分は、「中部圏開発整備法」における中部地域の定義に準拠し、富山県、石川県、福井県、長野県、岐阜県、静岡県、愛知県、三重県、滋賀県の９県とする。

第３節では、中部圏において地域間産業連関表を作成する目的が提示される。中部地域は、製造業中心の経済構造を有しており、地域間のスピルオーバー効果が明示的に現れている。我々は、最も信頼性のあ

るデータベースに依拠し、地域における政策的応用にとって意味のある地域間産業連関表を構築する必要がある。地域間産業連関表は様々な産業部門に関わる経済実態を定量的に把握するための優れた記述方法であると同時に、投入係数およびレオンチェフ逆行列などの各種係数と算式により容易に経済波及効果を導出することが可能な分析ツールでもある。さらに、地域間で異なる産業構造を明らかにすることができ、行政地域をベースにしながらもより広範囲の経済実態を分析することができる。

第４節では、中部圏地域間産業連関表を推計するための方法が提示される。地域間交易を推計するための方法として、行政機関等による特別調査によるサーベイ法と、既存の統計データおよび特化係数（Location Quotients；立地商）によるノンサーベイ法の２つの方法がある。空間的相互関係の解明のアプローチは２つあり、第１のアプローチは、経済産業省が地域産業連関表の推計のための特別調査として実施している「商品流通調査」によるものであり、第２のアプローチは「物流センサス」（国土交通省）および「国勢調査」（総務省統計局）等によるものである。

第５節では、中部圏地域間産業連関表の活用のための論点が提示される。第１の論点として、地域間産業連関表の作成に関する方法は、「商品流通調査」に代表されるサーベイ法とLQなどに代表されるノンサーベイ法であることが指摘される。第２の論点として、運輸・商業サービス部門を推計するための信頼できる統計データの探索と推計方法の開発が必要とされているという点が指摘される。第３の論点として、物量表示から貨幣表示への変換が必要であるという点が指摘される。

第６節では、産業連関表のよりよい理解のための論点について述べられている。第１に、部分均衡分析から一般均衡分析への転換について考慮することである。第２に、静学的な分析枠組みから動学的な分析枠組みへの展開が必要とされているという点である。第３に、空間の概念や技術的諸仮定について検討しなければならないという点である。

最後に、本稿におけるまとめとして、地域間産業連関表の作成と活用を行うにあたり、今後展開されるべき方向性が提示される。第１に、運輸部門の経済活動を分析するための方法を検討することである。第２に、重要な地域区分を分析する方法を検討することである。第３に、グローバリゼーションとローカリゼーションの同時進行を分析することである。

キーワード：産業連関表、記述方法、分析ツール、地域区分、産業分類、ノン・サーベイ手法

How to Compile and Utilize an *Interregional* Input-Output Table
— A Case Study of *Chubu* region in Japan —

Dr. Takeo Ihara, Dr. Michiya Nozaki, and
Mr. Nontachai Tithipongtrakul*

(Economic Analysis and Application Team, CIRAC)

Contents

Keywords: Input-Output Table, Descriptive Device, Analytical Tool, Regional Breakdown, Industrial Classification, Non-survey Method

1 Introduction

The aim of this paper is to consider the various problems prevalent in Chubu region in Japan, and compile and utilize an ***Interregional*** Input-Output (I-O) table for this purpose. The ***Interregional* I-O** table for this region may be utilized as the most reliable **database** in order to draw some meaningful policy implications for the problems encountered in therein. Thus, a brief review of the significance of compiling an I-O table and its Extensions is necessary at this stage.

An Input-Output table may be regarded as the most useful **descriptive device** utilized for a quantitative understanding of the actual economic activities among various industrial sectors. With the aid of this primitive transaction matrix, the input coefficient and Leontief inverse matrices can be readily derived, both of which may be regarded as **analytical tools**. However, for more sophisticated spatial (or, cross-border) transactions, an Interregional I-O table must be compiled as the most fundamental descriptive device. Moreover, when we compile an Interregional I-O table for ***Chubu region,*** we must explicitly take into account the following two aspects：**industrial classification** and **regional breakdown**.

Historically, there are various instances of the compilation of interregional I-O tables in Japan as well as in China. The first trial of an interregional I-O table in Japan was compiled for Kinki and Other Region by the Kansai Keizai Federation in 1957. Thereafter, an interregional I-O table was compiled by METI et al. for the years 1960-1995, as well as in 2005.

On the other hand, in China, an interregional I-O table comprising 9 Sectors and 7 Regions appears to be the original trial, which was compiled in 1987. Thereafter, a multi-regional I-O model for China 2000 was compiled by IDE-JETRO in 2005

In section 2, we consider why we must compile and utilize an I-O table for ***Chubu*** region in Japan. In section 3, we present the objective of compiling an I-O table for Chubu region. In section 4, we consider certain important methodological notes on estimating spatial relations in an International I-O table for Chubu region. In section 5, in addition to the above methodological notes, we comment on the utilization of an I-O table. In section 6, we consider certain aspects in order to improve understanding of an I-O table. In section 7, we present the concluding remarks.

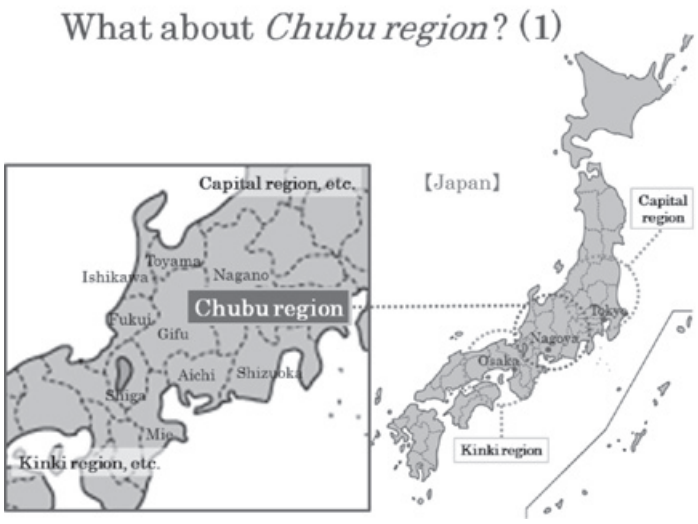
2 Geographical location of *Chubu* region

Chubu region is located in the central region of Honshu, Japan's main island in the Japanese archipelago. The region includes Nagoya, a major city, the Pacific and Sea of Japan coastlines, and Mount Fuji. It is rather difficult to delineate ***Chubu*** region because of its **openness** and **diversity.** For better understanding, we consider these two features of *Chubu region* individually. The first is the **external** conditions（or **openness**）and the second is the **internal** situations（or **diversity**）.

Chubu region has established close ties with other neighboring regions and/or countries, and with various transport infrastructures. For example, Central Japan Railway, Meishin and Tomei Expressway, Central Japan International Airport, etc. Moreover, the region possesses various regional resources that are not only natural resources, but also historical and/or cultural resources. For example, High-rise buildings of Nagoya city, Mt. Fuji, Biwa Lake, Ise Jingu, etc.

Further, Chubu region comprises 9 prefectures-Toyama, Ishikawa,Fukui, Nagano, Gifu, Shizuoka, Aichi, Mie, Shiga. Chubu region is also defined by the "Chubu region Development and Improvement Law".

Figure 1. The Openness and Diversity of Chubu region

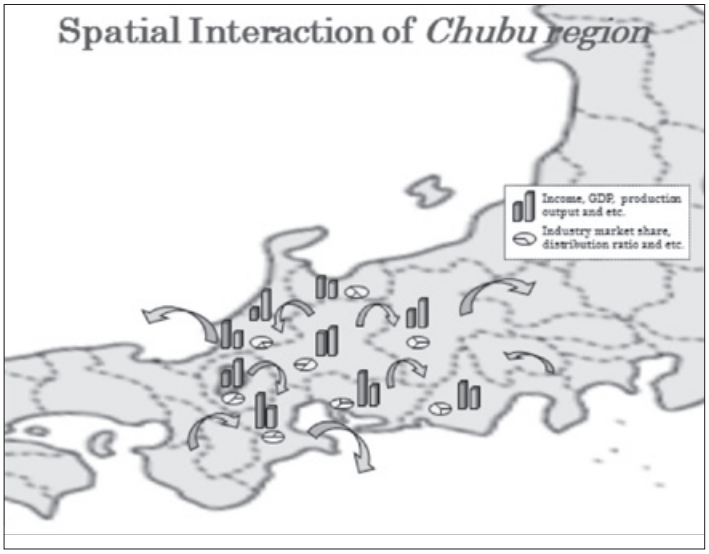


3 Why an Interregional I-O table ?

An I-O table may be regarded as the most useful **descriptive device** for obtaining a quantitative understanding of the actual economic activities among various industrial sectors.; these activities may include production activities, as well as the utilization of goods and services and the income generated therein. The goods manufacturing industry is the main industry in ***Chubu*** region. Moreover, there is evidence of the occurrence of the ***interregional*** spill-over effect in the region. This effect measures the increase in output in one region that is contributed by an increase in output in another region or province.

Therefore, in order to draw meaningful policy implications of this interregional spill-over effect, an ***interregional*** I-O table is compiled for the Chubu region; this table may be utilized as the most reliable **database** for this purpose.

Figure 2. Spatial Interaction in Chubu region



In the following account, we present a brief review of the significance of compiling an I-O table and its extensions.

With the aid of this primitive transaction matrix, the input coefficient and Leontief inverse matrices can be readily derived, which may be regarded as **analytical tools**. However, for more sophisticated spatial (or cross-border) transactions, we must compile an ***interregional*** I-O table as our most fundamental descriptive device.

When we compile an ***interregional*** I-O table for Chubu region in Japan, we must explicitly take into account the two aspects of **industrial classification** and **regional breakdown**.

The former describes how the classification of various industries usually differs from prefecture to prefecture in Chubu region.

The latter describes that economic activities are usually conducted broadly over judicial or political borders.

4 Methodological Notes on the Estimation of Spatial Relations

In this section, we discuss the estimation of Interregional Transactions" ?

Methodologically, these transactions can be estimated through the following two methods: The first is the Survey Method that is used to utilize the data obtained through official questionnaires. The second is the Non-survey Method, such as Simple Location Quotients, Purchases-Only Location Quotients, Cross-Industry Location Quotients, Flegg and others' Location Quotients (FLQ), and Augmented FLQ (AFLQ)[※1].

Further, with regard to how the data on spatial interaction must be considered, we use the following two types of approaches: The first approach is the utilization of the Commodity Circulation Survey by METI for the compilation of the restricted Multiregional I-O table. However, the Law of Statistics does not permit their details to be accessed by the public.

The second approach is to rely on another alternative method for compiling an interregional I-O table by utilizing the Freight Census (2005), Population Census (2005) and so on.

With regard to the Industrial Classification, judging from the latest available I-O tables of respective prefectures in Chubu region, we decided on 95 industries as the common number of various industries.

With regard to the Regional Breakdown, prefectures such as Toyama, Ishikawa, Fukui, Nagano, Gifu, Shizuoka, Aichi, Mie, Shiga, and rest of Japan are treated separately.

In addition, only one aggregated region is assumed where Imports and Exports are treated explicitly. Please refer to the Supplementary Note（International Transactions）.

Figure 3 presents the Analytical Framework for the Interregional I-O table for ***Chubu*** region.

Figure 3. Analytical Framework for the Interregional I-O table for Chubu region

		Intermediate Demand					Final Demand					Export	Import	Total Output
		Aichi (95)	Gigu (95)	…	Fukui (95)	ROJ (95)	Aichi (7)	Gigu (7)	…	Fukui (7)	ROJ (7)			
Intermediate Input	Aichi (95)													
	Gigu (95)													
	⋮													
	Fukui (95)													
	ROJ (95)													
Value-added	Aichi (7)													
	Gigu (7)													
	⋮													
	Fukui (7)													
	ROJ (7)													
Total Input														

5 The compilation and utilization of an I-O table

In this section, we present some comments on the compilation and utilization of an I-O table.

First, we comment on how inter-prefectural relations are determined. Two methods are used for this purpose-one is the Survey Method, which is based on the "Shohin Ryutsu Chosa"（or the Commodity Circulation Survey）, and the other is the Non-survey Method, which has been mostly derived from using Location Quotients（i.e., LQ's）

Second, we comment on how to deal with Transport and Commerce activities. Basically, all the data presented in an I-O table are usually derived from activity-based estimations; however, the Transport & Commerce sectors have not been treated adequately（or sufficiently）in an I-O table thus far.

The following three aspects in the context of our empirical studies thus far must be mentioned:

The first aspect is concerned with the estimation of spatial relations using the Non-survey Method. In order to determine the Inter-regional Commodity Flows, we calculate the trade coefficients among various regions in the following manner.

$$CQR_{A\to B} = \frac{\textit{Exported Commodity Flow from A to B}}{\textit{Imported Commodity Flows into B.}}$$

The above equation may be referred to the ***Inter-regional Circulation Quantity Ratio from A to B.***

Let x_i^r and x^r denote the gross output of sector i in region r and total output of all sectors in region r, respectively. Further, let x_i^n and x^n denote total gross output of sector i in region r and total output of all sectors in national level, respectively.

Therefore, the simple location quotient for sector I in region r is defined by the following formula.

$$LQ_i^r = \left(\frac{x_i^r / x^r}{x_i^n / x^n} \right) \qquad (1)$$

Note that simple algebra generates an alternative form, which is

$$LQ_i^r = \left(\frac{x_i^r / x_i^n}{x^r / x^n} \right)$$

The above expression may be interpreted in the following manner: If LQ_r^i>1, it indicates a commodity whose production is relatively localized in region r. If LQ_r^i <1, it indicates that industry i is less concentrated in the region than in the nation, and it is considered as less capable of satisfying regional demand through its output, and its regional direct input coefficients, a_{ij}^{rr} (j=1,⋯,n) are obtained by reducing the national coefficients, a_{ij}^n, by multiplying them with LQ_r^i (Miller and Blair,2009：pp.349-350).

$$a_{ij}^{rr} = \left\{ \begin{array}{cc} (LQ_r^i)\ a_{ij}^n & \textit{if } LQ_r^i\textit{<1 import-oriented} \\ a_{ij}^n & \textit{if } LQ_r^i\textit{<1 export-oriented} \end{array} \right\}. \qquad (2)$$

The second aspect is concerned with the Difference between Commodity Flows and Person Trip.

In other words, Commodity Flow has an Origin-scopic characteristic, while Person Trip has a Destination-scopic characteristic.

$$PTR_{A\to B} = \frac{\textit{The Person Trip from A to B}}{\textit{Total of the Person Trip into B}}$$

The above equation may be referred to as the ***Inter-regional Person Trip Ratio from A to B.***

The third aspect is concerned with the Measurement of Physical and Monetary units. Commodity Flows are measured in terms of physical units, while all entities in an I-O table are measured in terms of monetary units. Therefore, all the data on Commodity Flows must be converted from physical to monetary units.

In addition to the abovementioned three aspects, the following six points are discussed.

The first point is the manner in which International Trade is dealt with in an I-O table.

In the Competitive Import Scheme, we include a new column of Import; the quantity of import is written, at the intersection of the associated domestic row, with a negative sign.

In the Non-competitive Import Scheme, all types of imported goods are clearly distinguished from similar domestically produced goods; hence, these are written separately in additional rows.

The second point is the location of an I-O table within a System of National Accounts. Figure 4 presents an I-O table in a System of National Accounts (SNA). The data included in the SNA also enables expansion of the basic input-output framework to handle systematically such as the secondary production in the economy. These concepts are so called "commodity-by-industry" approach (Miller and Blair (2009), p.122).

Figure 4 An I-O table in a System of National Accounts (SNA)

Out / In	Commodity	Industry	F. D.	Output
Commodity		U	f	q
Industry	V	$I\text{-}O$		g
V. A.		y		
Output	q'	g'		

In this regard, we present the following model equations on how to derive an I-O table from U & V matrices.

The following are the Model Equations obtained on the basis of assuming the Commodity Technique:

$$q = (I - B C^{-1})^{-1} f \qquad (3)$$

and

$$g = (I - C^{-1} B)^{-1} C^{-1} f, \qquad (4)$$

where $U = B g$, $V' = C g$.

The following are the Model Equations obtained on the basis of assuming the Industry Technique:

$$q = (I - B D)^{-1} f \qquad (5)$$

and

$$\boldsymbol{g} = (\boldsymbol{I} - \boldsymbol{D}\,\boldsymbol{B})^{-1}\boldsymbol{D}\boldsymbol{f}, \qquad (6)$$

where $\boldsymbol{V} = \boldsymbol{D}\,\boldsymbol{q}$.

The third point is the relationship between producer's and purchaser's prices.

I-O accounts in terms of average producer's prices minus the difference between average and actual prices are equal to I-O accounts in terms of actual producer's prices. I-O accounts in terms of actual producer's prices plus commercial margins are equal to the I-O table in terms of actual purchaser's prices.

The fourth point is related to the utilization of an Interregional I-O table.

An I-O table may be regarded as the most useful descriptive device for gaining a quantitative understanding of the actual economic transactions among various sectors in a region.

The format of an I-O table is highly dependent on the ultimate aims of the analysts. The popularity of an I-O table may be ascribable to its operationality and manipulation.

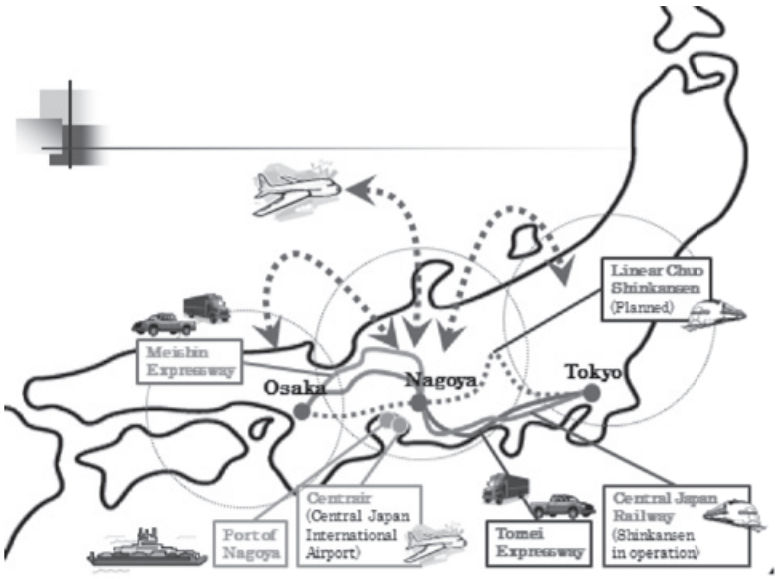
Therefore, an I-O table may be regarded as the most useful tool for understanding the economic structure of a region in a rather simple way and also for drawing some meaningful policy implications therein.

The fifth point is dealing with the Transport and Commerce sectors in a dynamic regional economy.

Thus, it is necessary to conduct Impact Studies, such as studying the economic effects of developing the Hokuriku Super-Express and/or economic effects of developing the Linear-Motor Central Line on Chubu region, etc. (see Figure 5).

The Impact Studies will enable an empirical analysis of the interregional dependency among various prefectures in **Chubu** region, and can also aid in the estimation and evaluation of the local governments' policy in light of the current trend of decentralization.

Figure 5



Lastly, the sixth point is the separation of international exports from domestic ones with respect to each prefecture. We are currently in the process of conducting empirical studies with regard to the abovementioned aspects (see Supplementary Notes).

6 Better Understanding of the I-O Model

In order to obtain a better understanding of I-O tables, it is essential to review the following aspects.

First, we must consider the transformation from the Partial Equilibrium Approach to the General Equilibrium Approach. The conventional I-O Model is the simplest and most naive model in terms of assumptions and limitations. The first assumption of this model is the fixed input coefficient. In fact, this assumption is not acceptable, because the economy is a changing entity. This can create problems if the time-frame between the base year and the exogenous shock is excessive, exacerbated by the time-lag involved in the table construction process. The second assumption regarding the linearity of the production system is a critical aspect in numerous cases. It implies a strict proportional relationship between input coefficients and output. The third assumption is an infinitely elastic supply of inputs, including labor, into the production process. Therefore, price has no role to play in the system.There is no feedback mechanism between primary factors (Value added) and the final demand in I-O model※2.

Second, we must shift from the Static to the Dynamic model. In the relationship among the abovementioned assumptions, we must consider intensive effects that are additional household-induced income changes from marginal changes in income of employed workers, and the redistributive effects that occur when local unemployed people become employed※3.

Third, we must consider the Concept of Space and Technical Assumptions, i.e., how to cope with Core-Periphery Structure. Krugman (1991) and Fujita, Krugman, and Venables (1999) present a framework to explain the interrelations between increasing return at the level of the firm, transport cost, and factor mobility in the emergence and evolvement of spatial economic structure. Fujita and Krugman (2004) indicated that the economy would reach its limit when forward and backward linkages were sufficiently strong to overcome the centrifugal force generated by immobile farmers. Moreover, they stated that the core-periphery pattern seemed to occur (i) when the transport cost of manufactures was sufficiently low, (ii) when varieties were sufficiently differentiated, and/or (iii) when the expenditure on manufactures was sufficiently large※4.

7 Concluding Remarks

When we compile an ***Interregional*** I-O table for ***Chubu*** region, we must explicitly take into account the following two aspects: industrial classification and regional breakdown. With the aid of this primitive transaction matrix, the input coefficient and Leontief inverse matrices may be readily derived, and may be regarded as analytical tools. However, if we are interested in more sophisticated spatial (or cross-border) transactions, we must compile an ***Interregional*** Input-Output table as our most fundamental descriptive device.

The following aspects are important with regard to the compilation and utilization of the I-O table.

The first aspect is concerned with the estimation of Spatial Relations using the Non-survey Method." In the ***Interregional*** Commodity Flows, we calculate the trade coefficients among various regions.

The second aspect is concerned with the difference between Commodity Flows and Person Trip. Commodity Flow has ***Origin-related*** characteristics, while Person Trip has ***Destination-related*** characteristics.

The third aspect is concerned with the Measurement of Physical and Monetary units.

The reason for the popularity of I-O tables may be ascribable to their operationality and manipulation. Therefore, it could be regarded as the most useful framework for obtaining a quantitative understanding of the economic structure in a rather simple manner and also to draw some meaningful policy implications. Thus, we must conduct Impact Studies that consider matters such as the economic effects of developing the Hokuriku Super-Express, and/or economic effects of developing the Linear-Motor Central Line on Chubu region.

Further, the following issues must be carefully taken into account in future empirical studies:

The first is how to deal with Economic Activities of Transport Sector in a Commodity-based I-O Table.

The second is how to conduct a Significant Regional Breakdown, in the context of the Spatial CGE Model.

The third is how to cope with the simultaneous occurrence of both Globalization and Localization.

Appendix : Supplementary Notes on the Separation of International and Domestic Exports

The international exports may be separated from domestic ones with respect to each prefecture using the following formula.

$$E_{(I)}^{Ken} = \left(\frac{E_{(I)}^{Chu}}{E_{(I)}^{Chu}+E_{(N)}^{Chu}}\right) E_{(\Sigma)}^{Ken} = \left(\frac{E_{(I)}^{Chu}}{E_{(\Sigma)}^{Chu}}\right) E_{(\Sigma)}^{Ken}$$

$$E_{(N)}^{Ken} = \left(\frac{E_{(N)}^{Chu}}{E_{(I)}^{Chu}+E_{(N)}^{Chu}}\right) E_{(\Sigma)}^{Ken} = \left(\frac{E_{(N)}^{Chu}}{E_{(\Sigma)}^{Chu}}\right) E_{(\Sigma)}^{Ken}$$

$$= E_{(\Sigma)}^{Ken} - E_{(I)}^{Ken}$$

E（I）represents international exports and E（N）represents domestic exports.

Ken denotes each prefecture in ***Chubu*** region.

Chu denotes ***Chubu*** region.

E（Σ）denotes the sum of international and domestic exports.

The equation of International Exports of Prefecture indicates that the "relative ratio of International Exports to Sum of Exports of ***Chubu*** region" is multiplied with the "Sum of International Exports of Prefecture."

The equation of Domestic Exports indicates that the "relative ratio of Domestic Exports to Sum of Exports of ***Chubu*** region" is multiplied by the "Sum of Exports of Prefecture." This also implies that the International Exports of Prefecture is subtracted from the Sum of International and Domestic Exports.

Notes

* Chubu Industrial and Regional Advancement Center (CIRAC), Nittochi Nagoya Building 15F, Sakae 2-1-1, Naka, Nagoya, Aichi, Japan, 460-0008.
E-mail : ihara@cirac.jp ; nozaki@cirac.jp ; benz@cirac.jp

※1 For Location Quotients, see Miller and Blair (2009), pp. 349–356 ; Flegg, Webber, and Elliott (1995) ; and Flegg and Webber (1997 ; 2000).

※2 For a comparison of the I-O, I-O and Econometric, and CGE models, see West (1995), pp. 214–215.

※3 Ibid., pp.213–215. For a discussion on qualifications and limitations of an Interregional I-O Analysis, see Ihara (2005), pp.14–23.

※4 See Fujita and Krugman (2004),pp.144–145.

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