

Identifying an Input-Output Framework by Means of Average Propagation Lengths: A Case Study for Ogaki city, Gifu prefecture

Michiya Nozaki(Faculty of Economics, Gifu Kyoritsu University)

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1. Introduction

This paper describes the production processes in the economy of the Tohoku region (i.e. the northern-east part of Japan) by using an interregional I-O framework.

Ogaki city is contained with Gifu prefecture in Japan. Gifu prefecture is one of the prefectures contained the Chubu region, the Central part of Japan.

Many studies address the question of how such interdependencies or linkages can be accurately measured (e.g. Chenery and Watanabe, 1958; Rasmussen, 1956; Miller and Lahr, 2001; Sonis, Guilhoto, Hewings and Martins, 1995). These studies have proposed various alternative measures for such inter-industry linkages.

In this paper, we use the concept of average propagation length (APL), which was presented by Dietzenbacher, Romero and Bosma (2005) and Dietzenbacher and Romero (2007), to study empirically the Tohoku region and Ogaki city in Gifu prefecture.

Oosterhaven and Bouwmeester (2013) discuss that 'the average propagation length (APL) has been proposed as a measure of a fragmentation and sophistication of an economy, and for a one-sector economy they show that the APL is strictly proportional to the macro multiplier of that economy' (Oosterhaven and Bouwmeester, 2013, 481). Chen (2014) also extends the definition of APL to the grouping-APL from the double-counting of APL.

Antràs, Chor, Fally, and Hillberry (2012) discuss that the fragmentation of production across national boundaries has been a discriminative feature of the world economy by the concept of forward linkages in Input-Output analysis on the empirical sides.

On Asian International Input-Output Tables, Inomata (2008) investigates the possibility of constructing a new measurement for analyzing international fragmentation of production process, and the new measurement is formulated by the Input-Output model of Average Propagation Lengths.

On the other hand, we have another applications of Average Propagation Length about indirect foreign trade-related R&D spillovers (Franco, Montresor, and Marzetti, 2011) and ownership relations in the presence of cross-shareholdings (Dietzenbacher and Temurshoev, 2008).

This paper is organized as follows. In section 2, we review the APL proposed by Dietzenbacher, Romero, and Bosma (2005), and Dietzenbacher and Romero (2007). In section 3, we use the APL concept to study the inter-industrial relationship in Ogaki city in Gifu prefecture.

In the last section, we present our concluding remarks.

2. A Review on Average Propagation Lengths (APLs)

When we define average propagation, we analyse how a cost-push or a demand-pull propagates

throughout the industries in the economy. According to Dietzenbacher, et al., (2005, 411-412), an initial demand-pull in industry i increases the output value in industry j by $l_{ij} - \delta_{ij}$ (neglecting the initial effects). δ_{ij} is the Kronecker delta; i.e. $\delta_{ij} = 1$ if $i = j$ and 0 otherwise. The share $a_{ij}/(l_{ij} - \delta_{ij})$ of this output increase requires only one round, but the share $[A^2]_{ij}/(l_{ij} - \delta_{ij})$ requires two rounds to get from i to j . $[A^2]_{ij}$ denotes the element (i,j) of matrix A^k , which differs from $(a_{ij})^k$ (Dietzenbacher, Romero, and Bosma, 2005, 411-412).

The average number of rounds required to pass over a demand-pull in industry i to industry j yields

$$v_{ij} = \{1a_{ij} + 2[A^2]_{ij} + 3[A^3]_{ij} + \dots\} / (l_{ij} - \delta_{ij}) \quad (2-1)$$

Let the numerator of the right-hand side of (2-1) be denoted by h_{ij} , with $H = \sum_k k A^k$.

Then the terms h_{ij} can easily be calculated by using

$$H = \sum_k k A^k = L(L - I).$$

We can reduced equation (2-1) to (2-2) as the matrix V of APL as follows:

$$v_{ij} = \begin{cases} \{1a_{ij} + 2[A^2]_{ij} + 3[A^3]_{ij} + \dots\} / (l_{ij} - \delta_{ij}) & \text{if } l_{ij} - \delta_{ij} > 0, \text{ when } i \neq j \\ \{1a_{ij} + 2[A^2]_{ij} + 3[A^3]_{ij} + \dots\} / (l_{ij} - 1) & \text{if } l_{ij} - \delta_{ij} = 0, \text{ when } i = j \end{cases} \quad (2-2)$$

Alternatively, in the same way, we can define the APL for a cost-push (Dietzenbacher, 1997; Oosterhaven, 1988). Analysing how a one-yen cost-push increase in industry j affects the total output of industry i , we find $b_{ij} + [B^2]_{ij} + [B^3]_{ij} + \dots = g_{ij} - \delta_{ij}$. The APL for a cost-push yields

$$\{1b_{ij} + 2[B^2]_{ij} + 3[B^3]_{ij} + \dots\} / (g_{ij} - \delta_{ij}) \quad (2-3)$$

Note that input matrix A and output matrix B are related to each other.

3. A Case Study for Ogaki City in Gifu Prefecture

Ogaki city is contained with Gifu prefecture in Japan. Gifu prefecture is one of the prefectures contained the Chubu region, the Central part of Japan. Major Leading industrial sectors in Ogaki city are manufacturing industries of the miscellaneous electronic components and motor vehicle parts and accessories.

To compile the 2011 Input-Output Table in Ogaki city, we can use the 2011 Input-Output Table for Gifu Prefecture (Production Prices Table, 108 sectors), 2012 Economic Census for Establishments and Enterprises in Gifu prefecture and Ogaki city.

Compiling process of Input-Output Table of Ogaki city is as follows:

- (1) To estimate regional domestic production in Ogaki city, we estimate those products by applying each regional industrial employee ratio between Ogaki city and Gifu prefecture.
- (2) Applying the input coefficients and value added coefficients of Gifu prefecture to Ogaki city, we estimate the total inputs of intermediate sectors and gross value added of industrial sectors in Ogaki city.
- (3) To estimate the final demand in Ogaki city, we can apply the population ratio, industrial employee ratio, etc. between Ogaki city and Gifu prefecture to get the value of the final demand in Ogaki city.
- (4) To estimate the internal and external exports in Ogaki city, we assume that the internal and external export-products ratios in Gifu prefecture and Ogaki city are equal. Besides, we can estimate the internal and external imports the following balancing equation.

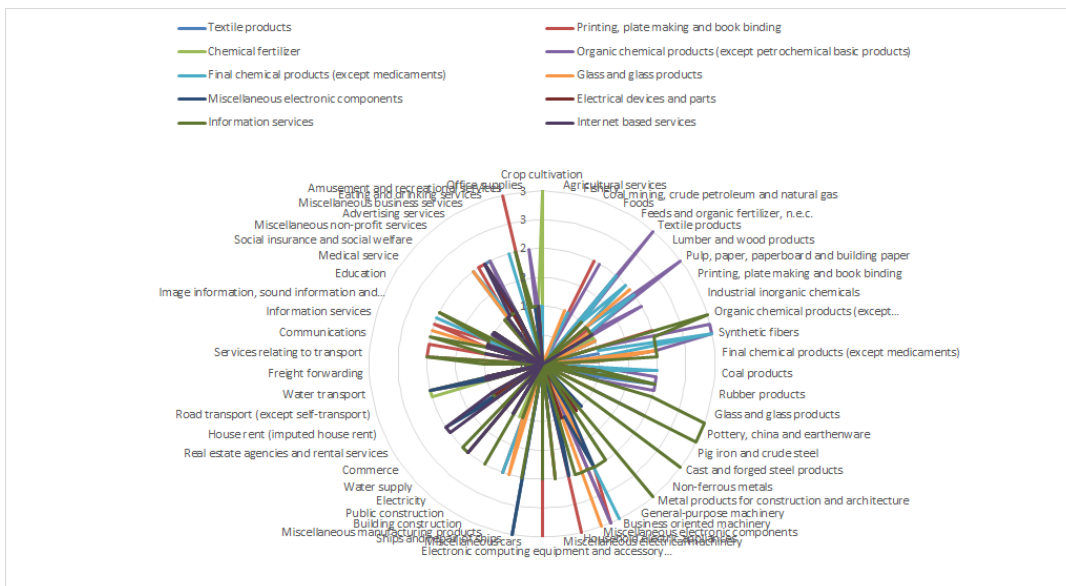
In Industries in the 2011 Input-Output Table in Ogaki city in Gifu prefecture, we select top 10 industries of LQ in Ogaki city. These are Textile products, Printing, plate making and book binding, Chemical fertilizer, Organic chemical products (except petrochemical basic products), Final chemical products (except medicaments), Glass and glass products, Miscellaneous electronic components, Electrical devices and parts, Information services, and Internet based services.

The Pearson correlation coefficient between backward APL and the matrix F in the 2011 Input-Output Table in Ogaki city equals 0.067299631. P-value is 0.0001.

The Pearson correlation coefficient between forward APL and the matrix F in the 2011 Input-Output Table in Ogaki city equals 0.067454488. P-value is 0.0001.

The threshold of F matrix is 0.003931.

Figure 1 Backward APL, S value (selected 10 industries)



Source: 2011 Input-output Table in Ogaki city

and machine repair services, Miscellaneous business services, and Office supplies.

Industries of round 2 are Household electric appliances, Electronic computing equipment and accessory equipment of electronic computing equipment, Finance and insurance, and Self-transport. The industry of round 3 is Motor vehicle parts and accessories.

About the forward linkage of Miscellaneous electronic components, industries of the direct propagation (round 1) are Miscellaneous metal products, Production machinery, Business oriented machinery, Electronic devices, Miscellaneous electronic components, Electrical devices and parts, Household electric appliances, Miscellaneous electrical machinery, Electronic computing equipment and accessory equipment of electronic computing equipment, Motor vehicle parts and accessories, Research, Motor vehicle maintenance and machine repair services, and Office supplies. Industries of round 2 are Non-ferrous metal products, Repair of construction, Electricity, Road transport (except self-transport), Self-transport, Information services, Goods rental and leasing services, and Miscellaneous business services. Industries of round 3 are Plastic products, Glass and glass products, and Commerce.

About the backward linkage of Organic chemical products (except petrochemical basic products), industries of the direct propagation(round 1) are Wearing apparel and miscellaneous ready-made textile products, Furniture and fixtures, Paper products, Industrial inorganic chemicals, Organic chemical products (except petrochemical basic products), Final chemical products (except medicaments), Coal products, Glass and glass products, Miscellaneous metal products, Miscellaneous manufacturing products, Repair of construction, Electricity, Commerce, Finance and insurance, Road transport (except self-transport), Self-transport, Information services, Research, Motor vehicle maintenance and machine repair services, and Activities not elsewhere classified. Industries of round 2 are Beverage, Printing, plate making and book binding, Medicaments, Plastic products, Rubber products, Leather, fur skins and miscellaneous leather products, Miscellaneous ceramic, stone and clay products, Household electric appliances, Miscellaneous electrical machinery, Miscellaneous business services, and Office supplies. Industries of round 3 are Textile products, Pulp, paper, paperboard and building paper, Synthetic resins, Synthetic fibers, Electronic devices, and Motor vehicle parts and accessories.

About the forward linkage of Organic chemical products (except petrochemical basic products), industries of the direct propagation(round 1) are Beverage, Textile products, Pulp, paper, paperboard and building paper, Industrial inorganic chemicals, Organic chemical products (except petrochemical basic products), Synthetic resins, Synthetic fibers, Medicaments, Final chemical products (except medicaments), Plastic products, Rubber products, Glass and glass products, Miscellaneous ceramic, stone and clay products, and Research.

Industries of round 2 are Wearing apparel and miscellaneous ready-made textile products, Furniture and fixtures, Paper products, Printing, plate making and book binding, Leather, fur skins and miscellaneous leather products, Miscellaneous metal products, Electronic devices, Household electric appliances, Miscellaneous electrical machinery, Motor vehicle parts and accessories, Miscellaneous manufacturing products, Repair of construction, Motor vehicle maintenance and machine repair services, Office supplies, and Activities not elsewhere classified. Industries of round 3 are Electricity, Commerce, Finance and insurance, Road transport (except self-transport), Self-transport, Information services, and Miscellaneous

business services.

About the backward linkage of Final chemical products (except medicaments), industries of the direct propagation (round 1) are Crop cultivation, Foods, Wearing apparel and miscellaneous ready-made textile products, Furniture and fixtures, Paper products, Printing, plate making and book binding, Industrial inorganic chemicals, Organic chemical products (except petrochemical basic products), Synthetic resins, Medicaments, Final chemical products (except medicaments), Plastic products, Glass and glass products, Miscellaneous ceramic, stone and clay products, Miscellaneous metal products, Repair of construction, Electricity, Commerce, Finance and insurance, Road transport (except self-transport), Information services, Research, Advertising services, Miscellaneous business services, Office supplies, and Activities not elsewhere classified.

Industries of round 2 are Textile products, Lumber and wood products, Pulp, paper, paperboard and building paper, Coal products, Rubber products, Miscellaneous manufacturing products, Self-transport, Image information, sound information and character information production, Goods rental and leasing services, Motor vehicle maintenance and machine repair services, and Cleaning, barber shops, beauty shops and public baths.

Industries of round 3 are Synthetic fibers, Business oriented machinery, and Motor vehicle parts and accessories.

About the forward linkage of Final chemical products (except medicaments), industries of the direct propagation (round 1) are Crop cultivation, Foods, Textile products, Wearing apparel and miscellaneous ready-made textile products, Lumber and wood products, Furniture and fixtures, Pulp, paper, paperboard and building paper, Paper products, Printing, plate making and book binding, Industrial inorganic chemicals, Organic chemical products (except petrochemical basic products), Synthetic resins, Synthetic fibers, Medicaments, Final chemical products (except medicaments), Coal products, Plastic products, Rubber products, Glass and glass products, Miscellaneous ceramic, stone and clay products, Miscellaneous metal products, Business oriented machinery, Motor vehicle parts and accessories, Miscellaneous manufacturing products, Repair of construction, Image information, sound information and character information production, Research, Goods rental and leasing services, Advertising services, Motor vehicle maintenance and machine repair services, Miscellaneous business services, Cleaning, barber shops, beauty shops and public baths, Office supplies, and Activities not elsewhere classified. Industries of round 2 are Electricity, Commerce, Finance and insurance, Road transport (except self-transport), Self-transport, and Information services.

About the backward linkage of Glass and glass products, industries of the direct propagation (round 1) are Non-metallic ores, Paper products, Industrial inorganic chemicals, Organic chemical products (except petrochemical basic products), Final chemical products (except medicaments), Plastic products, Glass and glass products, Miscellaneous ceramic, stone and clay products, Miscellaneous metal products, General-purpose machinery, Miscellaneous manufacturing products, Repair of construction, Electricity, Gas and heat supply, Commerce, Finance and insurance, Road transport (except self-transport), Services relating to transport, Research, Motor vehicle maintenance and machine repair services, Miscellaneous business services, and Activities not elsewhere classified. Industries of round 2 are Furniture and fixtures,

Medicaments, Business oriented machinery, Miscellaneous electrical machinery, Miscellaneous transportation equipment and repair of transportation equipment, Self-transport, Information services, and Goods rental and leasing services.

The industry of round 3 is Miscellaneous electronic components.

About the forward linkage of Glass and glass products, industries of the direct propagation (round 1) are Furniture and fixtures, Industrial inorganic chemicals, Organic chemical products (except petrochemical basic products), Medicaments, Final chemical products (except medicaments), Plastic products, Glass and glass products, Miscellaneous ceramic, stone and clay products, Miscellaneous metal products, General-purpose machinery, Business oriented machinery, Miscellaneous electronic components, Miscellaneous electrical machinery, Miscellaneous transportation equipment and repair of transportation equipment, Miscellaneous manufacturing products, Repair of construction, Research, Motor vehicle maintenance and machine repair services, and Activities not elsewhere classified. Industries of round 2 are Paper products, Electricity, Gas and heat supply, Commerce, Finance and insurance, Road transport (except self-transport), Self-transport, Services relating to transport, Information services, Goods rental and leasing services, and Miscellaneous business services. The industry of round 3 is Non-metallic ores.

About the backward linkage of Information services, industries of the direct propagation are Wearing apparel and miscellaneous ready-made textile products, Furniture and fixtures, Pulp, paper, paperboard and building paper, Paper products, Printing, plate making and book binding, Plastic products, Miscellaneous manufacturing products, Commerce, Finance and insurance, Real estate agencies and rental services, Road transport (except self-transport), Self-transport, Storage facility service, Communications, Information services, Internet based services, Image information, sound information and character information production, Miscellaneous non-profit services, Goods rental and leasing services, Advertising services, Motor vehicle maintenance and machine repair services, Miscellaneous business services, Miscellaneous personal services, Office supplies, and Activities not elsewhere classified. Industries of round 2 are Synthetic resins, Synthetic fibers, Medicaments, Final chemical products (except medicaments), Rubber products, General-purpose machinery, Production machinery, Electronic devices, Miscellaneous electronic components, Electrical devices and parts, Miscellaneous electrical machinery, Electronic computing equipment and accessory equipment of electronic computing equipment, Motor vehicle parts and accessories, Repair of construction, Electricity, Gas and heat supply, Services relating to transport, Broadcasting, Public administration, and Amusement and recreational services. Industries of round 3 are Organic chemical products (except petrochemical basic products), Cement and cement products, Pottery, china and earthenware, Miscellaneous ceramic, stone and clay products, Cast and forged steel products, and Metal products for construction and architecture.

About the forward linkage of Information services, industries of the direct propagation (round 1) are Furniture and fixtures, Pulp, paper, paperboard and building paper, Printing, plate making and book binding, Organic chemical products (except petrochemical basic products), Synthetic resins, Medicaments, Final chemical products (except medicaments), Rubber products, Cement and cement products, Pottery, china and earthenware, Miscellaneous ceramic, stone and clay products, Cast and forged steel products, Metal products for construction and architecture, General-purpose machinery, Production machinery,

Business oriented machinery, Electronic devices, Miscellaneous electronic components, Electrical devices and parts, Miscellaneous electrical machinery, Electronic computing equipment and accessory equipment of electronic computing equipment, Miscellaneous manufacturing products, Electricity, Gas and heat supply, Commerce, Finance and insurance, Real estate agencies and rental services, Road transport (except self-transport), Storage facility service, Services relating to transport, Communications, Broadcasting, Information services, Internet based services, Image information, sound information and character information production, Public administration, Research, Medical service, Social insurance and social welfare, Miscellaneous non-profit services, Goods rental and leasing services, Advertising services, Miscellaneous business services, Hotels, Amusement and recreational services, Miscellaneous personal services, and Activities not elsewhere classified.

Industries of round 2 are Wearing apparel and miscellaneous ready-made textile products, Paper products, Synthetic fibers, Plastic products, Glass and glass products, Motor vehicle parts and accessories, Repair of construction, Self-transport, Motor vehicle maintenance and machine repair services, and Office supplies.

About the backward linkage of Printing, plate making and book binding, industries of the direct propagation (round 1) are Pulp, paper, paperboard and building paper, Paper products, Printing, plate making and book binding, Final chemical products (except medicaments), Plastic products, Repair of construction, Electricity, Commerce, Finance and insurance, Real estate agencies and rental services, Information services, Internet based services, Image information, sound information and character information production, Research, Miscellaneous non-profit services, Goods rental and leasing services, Miscellaneous business services, Office supplies, and Activities not elsewhere classified.

Industries of round 2 are Foods, Organic chemical products (except petrochemical basic products), Business oriented machinery, Miscellaneous manufacturing products, Services relating to transport, Postal services and mail delivery, Communications, Internet based services, Public administration, Advertising services, and Motor vehicle maintenance and machine repair services.

Industries of round 3 are Electronic devices, Household electric appliances, Electronic computing equipment and accessory equipment of electronic computing equipment, and Amusement and recreational services.

About the forward linkage of Printing, plate making and book binding, industries of the direct propagation are Foods, Paper products, Printing, plate making and book binding, Final chemical products (except medicaments), Business oriented machinery, Electronic devices, Household electric appliances, Electronic computing equipment and accessory equipment of electronic computing equipment, Miscellaneous manufacturing products, Electricity, Commerce, Finance and insurance, Road transport (except self-transport), Services relating to transport, Postal services and mail delivery, Communications, Information services, Internet based services, Image information, sound information and character information production, Public administration, Research, Social insurance and social welfare, Miscellaneous non-profit services, Goods rental and leasing services, Advertising services, その Miscellaneous business services, and Amusement and recreational services.

Industries of round 2 are Pulp, paper, paperboard and building paper, Organic chemical products (except petrochemical basic products), Plastic products, Repair of construction, Real estate agencies and rental services, Self-transport, Motor vehicle maintenance and machine repair services, Office supplies, and

Activities not elsewhere classified.

About the backward linkage of Chemical fertilizer, industries of the direct propagation are Chemical fertilizer, Industrial inorganic chemicals, Miscellaneous ceramic, stone and clay products, Reuse and recycling, Electricity, Commerce, Research, Motor vehicle maintenance and machine repair services, and Activities not elsewhere classified. Industries of round 2 are Road transport (except self-transport), Self-transport, Public administration, and Miscellaneous business services. The industry of round 3 is Crop cultivation.

About the forward linkage of Chemical fertilizer, industries of the direct propagation are Crop cultivation, Chemical fertilizer, Industrial inorganic chemicals, Miscellaneous ceramic, stone and clay products, and Activities not elsewhere classified. Industries of round 2 are Electricity, Public administration, and Research. Industries of round 3 are Reuse and recycling, Commerce, Road transport (except self-transport), Motor vehicle maintenance and machine repair services, and Miscellaneous business services. The industry of round 4 is Self-transport.

About the backward linkage of Internet based services, industries of the direct propagation (round 1) are Printing, plate making and book binding, Repair of construction, Real estate agencies and rental services, Road transport (except self-transport), Self-transport, Communications, Information services, Internet based services, Education, Research, Goods rental and leasing services, Advertising services, Miscellaneous business services, and Activities not elsewhere classified. Industries of round 2 are Electricity, Commerce, Finance and insurance, and Motor vehicle maintenance and machine repair services.

About the forward linkage of Internet based services, industries of the direct propagation (round 1) are Commerce, Finance and insurance, Road transport (except self-transport), Communications, Information services, Internet based services, Research, Advertising services, Motor vehicle maintenance and machine repair services, Miscellaneous business services, and Activities not elsewhere classified. Industries of round 2 are Printing, plate making and book binding, Repair of construction, Electricity, Real estate agencies and rental services, Self-transport, Education, and Goods rental and leasing services.

We can sum up this section as follows:

In Industries in the 2011 Input-Output Table in Ogaki city in Gifu prefecture, we select top 10 industries of LQ in Ogaki city. These are Textile products, Printing, plate making and book binding, Chemical fertilizer, Organic chemical products (except petrochemical basic products), Final chemical products (except medicaments), Glass and glass products, Miscellaneous electronic components, Electrical devices and parts, Information services, and Internet based services.

The Pearson correlation coefficient between backward APL and the matrix F in the 2011 Input-Output Table in Ogaki city equals 0.067299631. P-value is 0.0001.

The Pearson correlation coefficient between forward APL and the matrix F in the 2011 Input-Output Table in Ogaki city equals 0.067454488. P-value is 0.0001.

The threshold of F matrix is 0.003931

From the point of view of the economic distance, in 5 industries (Chemical fertilizer, Organic chemical products (except petrochemical basic products), Final chemical products (except medicaments), Glass and

glass products, Miscellaneous electronic components) , there is the higher intensity of the propagation in the backward and forward APL and S value.

And, in 5 industries (Textile products, Printing, plate making and book binding, Electrical devices and parts, Information services, and Internet based services), there is lower intensity of the propagation in the backward and forward APL and S value.

Since the coefficients in **A** are measures of direct effects only, the direct backward linkage (Miller and Blair, 2009, 556) is as follows:

$$\mathbf{B}_d = \mathbf{i}'\mathbf{A} \quad (3-1)$$

To capture both direct and indirect linkages in an economy, column sums of the total requirements matrix, **L** were proposed as a total backward linkage measure (Miller and Blair, 2009, 557; Rasmussen, 1956) as follows:

$$\mathbf{B}_t = \mathbf{i}'\mathbf{L} \quad (3-2)$$

The row sums **Bi** are suggested as the measure of direct forward linkage (Miller and Blair, 2009, 558) as follows:

$$\mathbf{F}_d = \mathbf{B}\mathbf{i} \quad (3-3)$$

And the row sums of the Ghosh inverse are suggested as the measure of total forward linkage (Miller and Blair, 2009, 558) as follows:

$$\mathbf{F}_t = \mathbf{G}\mathbf{i} \quad (3-4)$$

On the direct backward linkage of an input-output table in Ogaki city, the industrial sectors with the bigger direct backward linkage are as follows: the livestock sector, the chemical fertilizer sector, the organic chemical products sector (except petrochemical basic products), the synthetic fibers sector, the non-ferrous metal products sector, the metal products for construction and architecture sector, the business oriented machinery sector, the electrical devices and parts sector, the miscellaneous electrical machinery sector, the electronic computing equipment and accessory equipment of electronic computing equipment sector, the motor vehicle parts and accessories sector, the gas and heat supply sector, and the internet based services sector.

On the total backward linkage of an input-output table in Ogaki city, the industrial sectors with the bigger total backward linkage are as follows:

the livestock sector, the non-metallic ores sector, the food sector, the beverage sector, the textile products sector, the wearing apparel and miscellaneous ready-made textile products sector, the lumber and wood products sector, the furniture and fixtures sector, the pulp, paper, paperboard and building paper sector, the paper products sector, the chemical fertilizer sector, the industrial inorganic chemicals sector, the organic chemical products sector (except petrochemical basic products), the synthetic resins sector, the synthetic fibers sector, the medicaments sector, the final chemical products sector(except medicaments), the coal products sector, the plastic products sector, the rubber products sector, the leather, fur skins and miscellaneous leather products sector, the glass and glass products sector, the cement and cement products sector, the miscellaneous ceramic, stone and clay products sector, the non-ferrous metal products sector, the metal products for construction and architecture sector, the general-purpose machinery sector, the

production machinery sector, the business oriented machinery sector, the electronic devices sector, the miscellaneous electronic components sector, the electrical devices and parts sector, the household electric appliances sector, the miscellaneous electrical machinery sector, the electronic computing equipment and accessory equipment of electronic computing equipment sector, the motor vehicle parts and accessories sector, the ships and repair of ships sector, the miscellaneous transportation equipment and repair of transportation equipment sector, the miscellaneous manufacturing products sector, the building construction sector, the repair of construction sector, the image information, sound information and character information production sector, the advertising services sector, the motor vehicle maintenance and machine repair services sector, the eating and drinking services sector, and the office supplies sector.

On the direct forward linkage of an input-output table in Ogaki city, the industrial sectors with the bigger direct forward linkage are as follows:

the livestock sector, the forestry sector, the synthetic resins sector, the synthetic fibers sector, the leather, fur skins and miscellaneous leather products sector, the pottery, china and earthenware sector, the non-ferrous metals sector, the non-ferrous metal products sector, the electronic devices sector, the image information, sound information and character information production sector, and the advertising services sector.

On the total forward linkage of an input-output table in Ogaki city, the industrial sectors with the bigger total forward linkage are as follows:

the livestock sector, the forestry sector, the pulp, paper, paperboard and building paper sector, the chemical fertilizer sector, the synthetic resins sector, the synthetic fibers sector, the leather, fur skins and miscellaneous leather products sector, the pottery, china and earthenware sector, the non-ferrous metals sector, the non-ferrous metal products sector, the electronic devices sector, the reuse and recycling sector, the image information, sound information and character information production sector, and the advertising services sector.

APL can be used as a model for the impact of the growth of the recipient economy and its constituent region. That if final demand of all sectors of the economy except one is =0; the growth effect on the economy may be estimated through the backward and forward linkages of the Non- zero final demand sector. The magnitude of the growth effect will differ between the sectors according to the strength and spread of backward and forward linkages of that sector.

4. Concluding Remarks

We aimed to determine the chains of intra-regional production structure for Ogaki city in Gifu prefecture. Besides, we have the following concluding points about Ogaki city.

Firstly, the Pearson correlation coefficient between backward APL and the matrix F in the 2011 Input-Output Table in Ogaki city equals 0.067299631.

P-value is 0.0001. The Pearson correlation coefficient between forward APL and the matrix F in the 2011 Input-Output Table in Ogaki city equals 0.067454488. P-value is 0.0001. The threshold of F matrix is 0.003931.

Secondly, from the point of view of the economic distance, in 5 industries (Chemical fertilizer, Organic

chemical products (except petrochemical basic products), Final chemical products (except medicaments), Glass and glass products, Miscellaneous electronic components), there is the higher intensity of the propagation in the backward and forward APL and S value.

Thirdly, in 5 industries (Textile products, Printing, plate making and book binding, Electrical devices and parts, Information services, and Internet based services), there is a lower intensity of the propagation in the backward and forward APL and S value.

Besides, APL can be used as a model for the impact of the growth of the recipient economy and its constituent region. That if final demand of all sectors of the economy except one is =0; the growth effect on the economy may be estimated through the backward and forward linkages of the Non-zero final demand sector. The magnitude of the growth effect will differ between the sectors according to the strength and spread of backward and forward linkages of that sector.

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