The Estimation and Analysis of the Head Office Sector in Each Intra-regional Input-Output Table in Tokyo, Aichi, Osaka, and Fukuoka in 2011

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Research

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Abstract
The central management functions of the economics, politics, and culture of Japan are concentrated in Tokyo or in other metropolitan areas. Extreme concentration in Tokyo has become a serious problem for Japan. There is a concentration of headquarter function in Tokyo that falls behind the concentration of profits of other regions. Production activities such as branch offices and factories usually take place in regions outside Tokyo. Indirect management activities, which supervise production activities, are called headquarter functional activities. There is a structure in which profits from other parts of the country are concentrated in Tokyo through the corporate division of labor. To analyze this mechanism quantitatively, we must apply input-output tables, which is appropriate to examine headquarter services as intermediate goods of direct production site activities. In this research, we estimate 37 head office sectors in each intra-regional input-output table in Tokyo, Aichi, Osaka, and Fukuoka, known as regions in which many Japanese head offices are located. Moreover, we analyzed the inter-regional relationships between the head offices located in these four regions and the dependence of these regional economy on headquarter functional activities. (183 words)

Keywords
headquarter / input-output table / regional economy / extreme concentration in Tokyo / inter-regional relationships / hierarchical structure /

Classification code : R11, R15

The Estimation and Analysis of the Head Office Sector in Each Intra-regional Input-Output Table in Tokyo, Aichi, Osaka, and Fukuoka in 2011

1. Introduction

The central management functions of the economics, politics, and culture of Japan are concentrated in Tokyo or in other metropolitan areas (for example, Tokyo, Kanagawa, Chiba, and Saitama). Extreme concentration in Tokyo has become a serious problem for Japan. Many discussions have taken place about extreme concentration in Tokyo since the 1980s. Some researchers have emphasized the merit of concentration in Tokyo on the basis of market fundamentalism. Others have criticized the phenomenon for the regional disparity and the overpopulation and depopulation problem as a result (Nakamura 2012). The latter say that Tokyo has maintained the capacity for growth by depending on the concentration of resources of other regions and that the whole country doesn't depend on Tokyo's capacity for growth. Thus, Tokyo can't maintain its capacity for growth when other regions run out of resources (Samuta 2014).

There is a concentration of headquarter function in Tokyo that falls behind the concentration of profits of other regions. Production activities such as branch offices and factories usually take place in regions outside Tokyo. Indirect management activities, which supervise production activities, are called headquarter functional activities.

Bloom and Grant defined headquarters as "a corporate unit that performs administrative and managerial functions at a location that is geographically separated from the corporation's production units." They continue their description as follows: "As corporations grew, they became more complex. To deal with complexity, corporations began to divide themselves into divisions that specialized in specific areas of the corporation's product and geographic portfolio. Over time, the managerial functions of the corporation were separated from the operating divisions, resulting in the creation of a headquarters as a specialized entity dedicated to the management of the corporate portfolio, physically separate from places of production." Corporations also exploit economies of scale by pooling functional resources at their headquarters and by providing business units with corporate services in areas such as human resources, tax, marketing, finance, and treasury. These are managerial efficiencies that make it easier and quicker to communicate and discuss strategy and make collective decisions (Bloom and Grant 2011).

There is a structure in which profits from other parts of the country are concentrated in

Tokyo through the corporate division of labor. When headquarters concentrate on Tokyo, office services follow them to support the activities that take place there. Industry and labor are increasingly concentrated in Tokyo (Ishida 1990).

To analyze this mechanism quantitatively, we must apply input-output tables, which is appropriate to examine headquarter services as intermediate goods of direct production site activities. In this research, we estimate 37 head office sectors in each intra-regional input-output table in Tokyo, Aichi, Osaka, and Fukuoka, known as regions in which many Japanese head offices are located.

2. Literature Review

The hierarchical national economic system, which refers to the national division of labor, was established under the centralized system after the war in Japan. Then, headquarters and central management functions were stationed in Tokyo, and low value-added manufacturing industries and suppliers of raw materials were located in rural areas. This prevented Tokyo from developing international and diverse urban functions for competing with other large cities. The national central management function struggled to accommodate the shift from the post-industrial stage to the knowledge economy, so the problem of extreme concentration in Tokyo caused severe stagnation in Tokyo urban function and the Japanese economy (Nakamura 2012).

The concentration of head offices in Tokyo beyond the hierarchical national economic system presented several other issues, such as agglomeration economies. It is strategically important for major enterprises to place head office sectors and planning and development sectors in Tokyo. Tokyo's industrial policy facilitates face-to-face communication and collection of information (as it supports research and development and favors treatment within the Japanese tax system) in order to promote the growth of large enterprises as a unified public and private sector effort (Sasaki 1997).

Tokyo has also been regarded as "the global city," like New York and London, because it has become an international financial center starting with the concentration of headquarter functions in the 1980s. Under the global organization management system, the hierarchical structure assigned the global cities to the position of the top of the multinational corporation, and the cities correspondence with each function of the system. In spite of the hierarchical structure, a more serious problem arose: urban economic autonomies are being lost in the external capital creation. Head offices absorb the profits made through production and sell activities in the regions of "branch economy" and "branch plant economy" in which the large-scale retail stores are located. As a result, the inducement effects on the regions are limited,

and the extreme concentration in Tokyo became an economic factor (Okada et al. 2016).

Business activities and local governments cannot be promoted without permissions and subsidies from the central government. Such a centralized political system causes diverse functions to concentrate in Tokyo (Kanakura 2008). Consequently, global city functions also concentrate in metropolitan areas. In this case, global city theory cannot explain the extreme concentration in Tokyo (Kamo 1988 and so on).

Bloom and Grant state that "these are the sort of enterprises with the geographic and operational scope to operate their own global value chains and to participate in other companies' global value chains. As such, there is a natural affinity between corporate headquarters and global value chains." They also mentioned that it is difficult to compare headquarters among countries, and it is not clear whether the number of headquarters matters as much as the nature of headquarters, due to the different ways of defining headquarters (Bloom and Grant 2011). Wang et al. (2016) obtained data from the China Statistical Yearbook and the Annual Survey of Industrial Enterprises regarding the five types of enterprises: foreign owned, Sino-foreign owned, state owned, domestically joint owned, and privately owned. Strauss-Kahn and Vives (2006) used headquarter-level data from Dun and Bradstreet (D&B) to define headquarters as a management center that is strictly differentiated from a plant. Klier and Testa (2002) analyzed Compustat data on puplicly traded companies and found that "data from the Census of Enterprise Statistics (U.S. Department of Commerce, 1992) are somewhat helpful in identifying employment at so-called auxiliaries, which are defined as separate establishments of multi-establishment companies that perform administration, management, research, and other supporting functions."

How have statistics indicated the headquarter functional activity in Japan? Production activities (goods and services sector) are counted as costs in factories (e.g., materials, electric power, labor). In addition, indirect management activities (e.g., general affairs) are also counted as production activities. If head office sectors and production sectors are separated regionally, the production activities are counted in the production regions. Nevertheless, the production activities are not counted in the regional head office data (Arai and Kim 2017).

The characteristics of a head office include that income is not generated and costs are generated for providing head office functional services. "Establishment and Enterprise Census" just included head offices as basic statistics (primary statistics) for the purpose of making lists of all establishments and enterprises. Otherwise, statistics have been improved to examine head offices as derived statistics for Tokyo tables since the 1980s. This is because the headquarter functional activities are major product activities in Tokyo, so the Gross Domestic Product (GDP) of Tokyo is estimated as too small, and we cannot see the

characteristics of Tokyo separate from head office sectors. As a result, derived statistics have exceeded basic statistics to examine head offices (Suga 2012).

The outflows and inflows of head office sectors to subsidiary establishments located elsewhere have been estimated since 1960 as inter-regional input-output tables by the Ministry of Economy, Trade, and Industry (Arai and Kim 2017). Nevertheless, head office sectors haven't been estimated as input-output tables of Japan and prefecture except Tokyo, The System of National Accounts (SNA), and Prefectural Accounts. It isn't necessary for I-O tables and SNA to separate the total products from head office sectors. The economy of prefectures except Tokyo depend relatively chiefly on production activities. Thus, head office sectors have not been counted (Kaneko 1996).

In contrast, the improvement of statistics of head offices was considered to be a primary issue to compile the input-output tables of Tokyo. The "Special Survey for Compiling Input-Output Table" has been used to compile the Tokyo table in 1985, in which head office sectors were recorded and examined up to the present. The Ministry of Economy, Trade, and Industry estimated prefectural tables using costs of management from "Mining and manufacturing industries" for the compilation of I-O tables of Japan. Since 1990, estimating prefectural tables using the "Survey on Management Activities of Enterprises," the Ministry of Internal Affairs and Communications (MIC) examined the breakdown of the total expenditure of administrative or ancillary activities as one of various input surveys for the compilation of I-O tables. However, they cannot record head office sectors like Tokyo tables (Arai and Kim 2017).

Against this background, there was no "head office" sector in the Japan Standard Industrial Classification until the 1980s. In the 9th revision in 1984 and 10th revision in 1993 of the Japan Standard Industrial Classification, establishments engaged in administrative activities were included in the establishment managed by them and were deemed to be one establishment as a whole. For example, the head office sector of automobile manufacturers would be included in the automobile sector. Thus, head office sectors were treated as the same sector with establishments for which head offices provide services. Consequently, headquarter functional activities are absorbed into each sector. However, these industrial classifications couldn't express the characteristics of the Tokyo economy (Suga 2012). In order to compile I-O tables of Tokyo, the head office sectors are separated from the goods and services sectors with the following four assumption of compilation (Shimizu 1990 and so on).

"The concept of head office sectors is defined as the following assumption of compilation.

(1) The unit of statistics composing each head office sectors targets independent headquarter functional establishments that have establishments and are only engaged

in headquarter functional activities (indirect management activities).

(2) The output from head office sectors are inputted as only intermediate goods into goods and services, direct production activities.

(3) The output from the head office sectors are inputted into one or more specific goods and services sectors. Simultaneously, the number of head office sectors is equal to the number of goods and services sectors. Regarding the public administration sector, head office sectors are not arranged.

(4) Concerning the direct production activities of goods and services sectors, only one kind of headquarter functional activities are inputted. Therefore, the integration of head office sectors depends on the industrial variety of production activities that each head office controlled. That means the headquarter functional activities are inputted into one or more kinds of production activities, but multiple headquarter functional activities are not inputted into one production activity."

In the 12th revision in 2007 of the Japan Standard Industrial Classification, industrial statistics was improved to examine the headquarter functional activities as basic statistics. "Establishments engaged in administrative or ancillary economic activities" were established as a minor classification for each medium industrial classification. "Economic Census for Business Frame" (survey year was 2009) and "Economic Census for Business Activity" (survey year was 2012) were surveyed based on the Japan Standard Industrial Classification upon this revision (Suga 2012). In the questionnaires of Economic Census, head offices are defined as follows. "Head Offices refer to establishments which hold branch offices at different locations run by the same management agency and which control all of them. When each department belonging to a head office is located in a number of separate locations, an establishment where a representative like a president works is regarded as the head office and other establishments are regarded as branch offices."

The more large scale a corporation becomes, the more large scale the number of establishments becomes. Such a corporation separates head offices that assume administrative or ancillary activities and indirect management from subsidiary establishments (e.g., factories, sales offices), much like corporate division of labor. Each department at a different location is run as a single establishment (Shimizu 1990 and so on). The indirect activities mean head offices provide direct production establishments with services, for instance order and management of materials and sale and advertisement of products (Arai and Kim 2017 and so on).

As a consequence, we exclude single unit establishments from head offices and regard management establishments of multiple establishments as head offices in this paper. We treat

head office services as intermediate goods of the goods and services sectors.

After the improvement of statistics, studies to analyze headquarter functions quantitatively have increased. Although the Tokyo table was the latest regional I-O table, its compilation and analysis were improved by collaborative research, "Economic Structure of Tokyo Megalopolis." First, Ishida (1990) considered the characteristics of the Tokyo economy to compile I-O tables in Tokyo. As one of the characteristics, Shimizu (1990) argued the necessity of head office sectors and considered how to treat them in I-O tables in Tokyo. In conclusion, he described the significance of compilation as inter-regional I-O tables, because headquarter functional activities in Tokyo as intermediate goods are directly combined with production activities of goods and services sectors in other regions. Finally, the I-O table of Tokyo in 1985, or the inter-regional I-O table of Tokyo and the rest of Japan, was compiled. Arai et al. (1992) analyzed the economy of Tokyo using this table. The researchers then, found that 80% or more of headquarter functional activities in Tokyo are induced by the final demand of the rest of Japan. The results are also consistent with the findings by Takahashi (1991), Ishida et al. (1996), and so on.

Suga (2012), in reference to the characteristics of headquarter functional activities, stated that income is not generated and costs are generated. He also described the necessity of analysis of inter-regional I-O table, in consideration for cases of head offices and other controlled establishments are located in separate locations.

So, we find that it is important to analyze regional relationships concerning headquarter functional activities. If the head office sectors are estimated with I-O tables in each region, we can examine regional relationships independently.

Unfortunately, the head office sectors are not estimated in I-O tables other than the Tokyo table all over the world, so headquarter functional activities in neither regions nor nations are obvious. The Tokyo tables after 2008 have only one head office sector, which is why we cannot analyze each headquarter functional activity. So, Suhara and Ishiro (2019) estimated head office sectors in each intra-regional I-O table of the Kanto region (Tokyo, Kanagawa, Chiba, Saitama, Ibaraki, Tochigi, Gunma, Yamanashi, Shizuoka, Niigata, and Nagano). However, head office sectors of other regions are not obvious. In this paper, we estimated the head office sector in each intra-regional I-O table in Aichi, Osaka, and Fukuoka and separated 37 head office sectors departments from one head office sector in the Tokyo table.[1] In this paper, we will examine the results such as the inducement effect of regional

[1] In this paper, we estimate head office sectors in each intra-regional I-O table in 2011. With the data limitations, we can estimate the latest in 2011. This is the research task about later estimations.

headquarters by exports to other regions, because headquarters activities mainly transact with direct production site activities located in other regions. We focus on the regional relationship and the dependence on headquarter functional activities with regard to Tokyo, Aichi, Osaka, and Fukuoka, which play an important role in the Japanese economy.

3. The Process of This Estimation

3-1 The Estimation of Head Office Sectors in Each Intra-regional Input-Output Table (Aichi, Osaka, and Fukuoka)

In the process of compilation of the I-O table in Japan, it is likely that the intermediate goods of prefectural tables include headquarter functional activities. So, we estimate the head office sectors on the presupposition that headquarter functional activities are absorbed in the intermediate goods of compiled prefectural intra-regional I-O tables. That means that we also estimate 37 goods and services sectors in the way we separate estimated 37 head office sectors from each compiled prefectural intra-regional I-O table. Here I introduce the process of estimation of head office sectors in Aichi, Osaka, and Fukuoka as an example of Aichi (Fig. 1[2]).

[2]In Figure. 1, we do not estimate the exports and the imports of head office sectors, so we omit them. We also do not estimate the regional final-demand of head office sectors in this paper. The products of head offices, measured as costs of internal corporate, depend on value added (for instance, ware) because they do not produce goods directly. Head offices provide services as intra-firm transactions. That is the reason there is no final-demand of the head office sectors. The products of head offices are not treated as the final-demand, but as the intermediate-demand (Ishida 1990). The I-O tables in Tokyo treat headquarter function as such. We will not estimate regional final-demand of head office sectors on the premise that headquarter functional activities do not produce final goods in this estimation.

Fig. 1 The Conceptual Chart of This Estimation (Aichi, Osaka, and Fukuoka)

		Intermediate Demand		Regional Final-Demand	Outflows	(less) Inflows	Regional Products
		Goods and Services Sectors	Head Offices Sectors				
Interme-diate Input	Goods and Services Sectors	D	Z	P	K	O	X
	Head Offices Sectors	D*			K*	O*	X*
Gross Value Added		V	V*				
Regional Products		X	X*				

i The Estimation of the Total Products (X*) of the Head Offices Located in the Region

i -1 The Calculation of Per Expenses of Employees of the Head Offices in Japan

Based on the hypothesis that per expenses of employees of the head offices are equal in each region, we estimate the expenses of head offices located in Aichi using "per expenses of employees of the head offices in Japan." Per expenses of employees of the head offices in Japan are calculated by dividing "expenses of employees of the head offices in Japan" by "the total number of employees of the head offices in Japan." We obtained the "expenses of employees of the head offices in Japan" from "Survey on Management Activities of Enterprises" (2011) by MIC. "The total number of employees of the head offices in Japan" is calculated as the sum of the employees of the head offices by prefecture obtained from "Economic Census for Business Activity" (2012). "Expenses of employees of the head offices in Japan" and "the total number of employees of the head offices in Japan" are medium industrial classification of Japan Standard Industrial Classification. So, we calculate "per expenses of employees of the head offices in Japan" after integrating them in Major Aggregated Classification (37-sector classification) like I-O tables.

i -2 The Calculation of the Total Products of the Head Offices Located in the Region

We calculate the total products of the head offices located in Aichi (X*) by multiplying

"the total number of employees of the head offices in Aichi" and "per expenses of employees of the head offices in Japan" together. "The total number of employees of the head offices in Aichi" is obtained from the Economic Census as in the case of "the total number of employees of the head offices in Japan" above and is integrated in the "Major Aggregated Classification."

ii The Calculation of the Cost Structure of the Head Offices of the Region

We obtained "the input coefficient and the gross value added coefficient of the head offices in Japan" from "Survey on Management Activities of Enterprises" by MIC in order to calculate them in the case of Aichi. We calculate intermediate input (Z) and gross value added (V*) by multiplying (X*) by "the input coefficient and the gross value added coefficient of the head offices in Japan," respectively.

iii The Calculation of Each Item Except the Head Office Sectors

We calculate the intermediate goods of goods and services sectors (D) separating from Z calculated in ii from the intermediate goods of existing intra-regional tables. We use the regional final-demand (P), the outflows (K), the inflows (O), the exports (E), the imports (M), and the total products (X) in the existing tables in Aichi as goods and services sectors.

iv The Calculation of the Rate of Expenses of the Head Offices (Japan)

We obtained the sales amount and expenses of head offices in medium industrial classification in Japan Standard Industrial Classification from Table 1 of the "Survey on Management Activities of Enterprises." We calculated "the rate of expenses of the head offices" (A) by "expenses of the head offices" ÷ "the sales amount," after integrating the sales amount and expenses of the head offices in the Major Aggregated Classification.

v The Calculation of Expenses of the Head Offices (Intermediate Demand) of the Region

We estimate "expenses of the head offices of Aichi" on the presupposition that each rate of expenses of the head offices equals by region. We calculate "expenses of the head offices of Aichi" (D*) by multiplying (A) and the total products of goods and services sectors of Aichi. The result of this calculation, the vector (D*) is placed as diagonal elements to produce the diagonal matrix ($\widehat{D^*}$), because the outputs of head office sectors are the inputs of the same departments in goods and services sectors.

vi The Calculation of Outflows of the Head Offices Located in the Region

vi-1 The Calculation of Per Expenses of Employees of the Head Offices in the Region

"Per expenses of employees of the head offices in Aichi" (I) is obtained by dividing (D*) by "the total number of employees of establishments which have the head offices in Aichi." "The total number of employees of establishments which have the head offices in Aichi" includes the number of employees of the head offices. This is because the outflows and the inflows of head office sector exist in the same row with D*, as it is necessary to estimate based on D*, and we use D*, not D.

vi-2 The Calculation of Outflows of the Head Offices Located in the Region

The vector K* (the outflows of head office sectors) is calculated by multiplying (I) and "the total number of employees of establishments except those locating Aichi, which have the head offices in Aichi" together.

vii The Calculation of Inflows of the Head Offices Located in the Region

Conversely, the vector O* (the inflows of head office sector) is calculated by multiplying (I) and "the total number of employees of establishments locating Aichi, which have the head offices in except Aichi" together. The inflows of head office sectors are regarded as the summation of outflows of head office sectors located in other regions. That is because the outflows from the head offices located in other regions to direct production activity (goods and services sectors) in Aichi are obtained from "the total number of employees of establishments locating Aichi, which have the head offices in locations except Aichi."

viii The Calculation of the Outflows of the Head Offices by Region

The outflows of the head office sectors are resolved for the ratio of industrial employees by prefecture (46 prefectures, except Aichi) within Japan. The result of this calculation indicates which prefectures and how many outflows of the head office sector of Aichi in the respective sectors are produced.

3-2 The Separation of 37 Head Office Sectors Departments from One Head Office Sector in the Tokyo Table

Then we estimate 37 head office sector departments from one head office sector in the

existing Tokyo table (Fig. 2[3]).

Fig. 2 The Conceptual Chart of This Estimation (Tokyo)

		Intermediate Demand		Regional Final-Demand	Outflows	(less) Inflows	Regional Products
		Goods and Services Sectors	Head Offices Sectors				
Interme-diate Input	Goods and Services Sectors	D	Z	P	K	O	X
	Head Offices Sectors	D*			K*	O*	X*
Gross Value Added		V	V*				
Regional Products		X	X*				

i The Compilation of the Matrix ($\widehat{D^*}$) of the Intermediate Input of the Head Office Sectors

In the existing Tokyo table, the row vector (D*), which indicates the intermediate input of head office sectors corresponding to 37 goods and services sectors, is placed as diagonal elements to produce the diagonal matrix ($\widehat{D^*}$) here, handled in the same manner as Aichi, Osaka, and Fukuoka, because the outputs of head office sectors are the inputs of the same departments in goods and services sectors.

ii The Compilation of the Vector (X*) of the Total Products of the Head Office Sectors

In the existing Tokyo table, the total products of head office sector are recorded as only one sector. We calculate "the total number of employees of the head offices in Tokyo" × "per expenses of employees of the head offices in Japan" as in other regions. The ratio of this result by industrial sector, multiplied by the total products of one head office sector is "the

[3] In Fig. 2, the colored cells indicate the items from an estimated 37 head office sector departments from one head office sector in the existing Tokyo table. In addition, exports and imports are omitted, because they are not estimated.

total products of 37 head office sectors" (X*).

iii The Compilation of the Matrix (Z) of the Cost Structure of the Head Office Sectors

In the existing Tokyo table, there is the column vector of one head office sector (37 rows). Here, this vector is regarded as a fixed horizontal sum, and their vertical sum distributed by the rate of X* is regarded as a fixed vertical sum. Using the RAS method, the column vector of one head office sector become a matrix (Z) of 37 head office sectors.

iv The Compilation of the Vector (K*) and (O*) of the Outflows and Inflows, Respectively

The "Per expenses of employees of the head offices in Tokyo" (I) is obtained by dividing (D*) by "the total number of employees of establishments which have the head offices in Tokyo." The vector K* (the outflows of head office sectors) is calculated by multiplying "the existing outflows of one head office sector" and "the ratio of the following calculation by industrial sectors" together; (I) × "the total number of employees of establishments except those located in Tokyo, which have the head offices in Tokyo." The vector O* (the inflows of head office sectors) is obtained the same way.

v The Compilation of the Outflows of the Head Offices by Region

As in the case of the other regions, the outflows of head office sectors are resolved for the ratio of industrial employee by prefecture (46 prefectures, except Tokyo) within Japan.

4. Analysis Model and Result

4-1 The Outflows of Regional Headquarters and The Inducements Effects by them

We examine the regional relationship between Tokyo, Aichi, Osaka, and Fukuoka using the outflows of the head office sectors by region as estimated in the above procedure. In addition, the inducement effects of regional headquarters by exports to other regions are used for the following analysis and calculated as indicated below.

The intra-regional input-output model equation can be presented as follows:

$$x = Ax + f + e_r + e_w + m + n \qquad (1)$$

where x refers to the regional production; Ax denotes the regional intermediate transaction matrix (input coefficient "A" is multiplied by "x"); f denotes the regional final-demand; e_r denotes the outflows; e_w denotes the exports; n denotes the inflows; and m denotes the imports. Within the head office sectors, the intermediate inter-industrial transactions, regional final demand, exports and imports are 0.

From (1) above, the following equation can be obtained:

$$x = \left(I - \left(I - \widehat{M} - \widehat{N}\right)A\right)^{-1}(fd + e_r + e_w) \qquad (2)$$

Here, the diagonal matrices $(\widehat{M})$ and $(\widehat{N})$ can be assumed to have an import coefficient and inflow coefficient as the diagonal element, respectively, and zero as the non-diagonal element. In addition, "I" is an Identity matrix; fd is defined as "f$\times\left(I - \widehat{M} - \widehat{N}\right)$." Then, this model divides the inverse matrix coefficients above into goods and services sectors (a) and head office sectors (h), expressing them in a matrix as follows:

$$\left(I - \left(I - \widehat{M} - \widehat{N}\right)A\right)^{-1} = \begin{bmatrix} B_{aa} & B_{ah} \\ B_{ha} & B_{hh} \end{bmatrix} \qquad (3)$$

In contrast, e_{hr} represents the outflows of the head office sectors. Thus, the inducement effects of regional headquarters by exports to other regions can be obtained as follows:

$$\begin{bmatrix} B_{aa} & B_{ah} \\ B_{ha} & B_{hh} \end{bmatrix} \begin{bmatrix} O \\ e_{hr} \end{bmatrix} = \begin{bmatrix} B_{ah}e_{hr} \\ B_{hh}e_{hr} \end{bmatrix} \qquad (4)$$

We use the sum of $B_{ah}e_{hr}$ and $B_{hh}e_{hr}$ as the inducement effects of regional headquarters by exports to other regions in this paper. This result refers to the inducement effects generated within the goods and services sectors and head office sectors in total. Here, e_{hr} is divided into 46 prefectures except the original region. As a result, "$B_{ah}e_{hr} + B_{hh}e_{hr}$" are obtained by region in 46 prefectures.

Table 1 shows the respective outflows of the head office sectors by region, Table 2 shows their inducement effects, and Table 3 shows their ratio within Japan. Regions on the side of Table 1 are those in which the outflows of head office sectors are produced; regions at the top indicate those in which the inflows of goods and services sectors are supplied. Regions at the side of Table 2 are those in which the outflows of head office sectors have been produced; regions at the top indicate those in which the outflows from head office sectors generate outflows inducement. Regions at the side of Table 3 are those in which the outflows or the outflows inducements of head office sectors have been produced; regions at the top indicate the ratios of those within Japan, looking left.

These tables show that each region except Tokyo mostly depends on Tokyo within these four regions. Moreover, Tokyo and Osaka have an intensive relationship because their ratio is the highest. In addition, the ratio of dependence of Tokyo on Aichi is smaller than the ratio of dependence of Aichi in relation to Tokyo. Fukuoka has less intensive relationships within these regions relatively.

Table 1 Respective Outflows of Head Office Sectors by Region

Unit: ¥

	Tokyo	Aichi	Osaka	Fukuoka	Total of Them	Total of Japan
Tokyo		2,176,678	3,858,555	1,398,409	7,433,642	31,131,106
Aichi	917,357		343,635	110,817	1,371,809	8,344,841
Osaka	1,392,093	492,790		345,512	2,230,395	11,290,771
Fukuoka	305,037	72,918	125,931		503,886	5,689,483
Total of Them	2,614,487	2,742,386	4,328,121	1,854,738	11,539,733	

Table 2 The Respective Inducement Effects Generated by Outflows of Head Office Sectors by Region

Unit: ¥

	Tokyo	Aichi	Osaka	Fukuoka	Total of Them	Total of Japan
Tokyo		2,960,758	5,259,293	1,906,292	10,126,343	42,333,415
Aichi	1,335,336		500,793	161,599	1,997,728	12,159,773
Osaka	2,028,788	718,185		505,599	3,252,572	16,513,966
Fukuoka	443,431	106,382	182,161		731,974	8,275,562

Table 3 The Ratio of Respective Outflows or Inducement Effects Generated by Outflows of Head Office Sectors by Region

	Tokyo	Aichi	Osaka	Fukuoka	Total of Them
Tokyo		7.0%	12.4%	4.5%	23.9%
Aichi	11.0%		4.1%	1.3%	16.4%
Osaka	12.3%	4.4%		3.1%	19.8%
Fukuoka	5.4%	1.3%	2.2%		8.9%

4-2 The Regional Balance of Payments

Table 4 is the regional balance of payments about the inducement effects generated by the outflows of the head office sectors. This shows whether each region at the side of the table is in surplus or deficit in each transaction with regions at the top of the table. Tokyo is in surplus within these three regions. In contrast, Fukuoka is in deficit within these three regions. Aichi is in deficit with Tokyo and Osaka, and is in surplus with Fukuoka. Osaka is in surplus with Aichi and Fukuoka, and is in deficit with Tokyo.

Table 4 The Balance of Payments about Inducements Effects Generated by the Outflows of Head Office Sectors

Unit: ¥

	Tokyo	Aichi	Osaka	Fukuoka
Tokyo		1,625,422	3,230,505	1,462,861
Aichi	-1,625,422		-217,393	55,217
Osaka	-3,230,505	217,393		323,438
Fukuoka	-1,462,861	-55,217	-323,438	

The ratio of the surplus or the deficit (as showed in Table 4) within the gross value added of the head office sectors by region is depicted in Table 5. When looking at Tokyo, the ratio of the surplus with Osaka is the highest among them. With respect to Fukuoka, the ratio of the deficit with Tokyo is significantly higher than those with the other regions. Observing Aichi, the ratio of the deficit with Tokyo is higher than that with Osaka. As inferred from Osaka, the ratio of the deficit of Tokyo is higher than those with the other regions. This indicates also that Tokyo and Osaka have an intensive relationship.

Table 5 The Ratio of the Surplus or the Deficit within Gross Value Added of Head Office Sectors by Region

	Tokyo	Aichi	Osaka	Fukuoka
Tokyo		10.0%	19.8%	9.0%
Aichi	-30.1%		-4.0%	1.0%
Osaka	-44.9%	3.0%		4.5%
Fukuoka	-43.4%	-1.6%	-9.6%	

Thus, the inter-regional relationships among Tokyo, Aichi, Osaka, and Fukuoka regarding headquarter functional activities can be regarded as the hierarchical structure, which means Tokyo is superior to these three regions, Osaka is superior to Aichi and Fukuoka, and Aichi is superior to Fukuoka. In addition, the transaction between Tokyo and Osaka is relatively intensive. We also find that the head offices located in Tokyo tend to generate large profits by providing head office services to Osaka.

4-3 The Ratios of Dependence on Inducement Effects Generated by Outflows of Head Office Sectors

Furthermore, we examine the dependence on headquarter functional activities economically by region. Table 6 is the industrial ratios of dependence on the inducement effects generated by the outflows of head office sectors by region, calculated by dividing the "inducement effects generated by outflows of head office sectors" by "regional products of head office sectors." Observing entire industries, Tokyo has the highest ratio (114%, which means inducement effects exceed regional products), followed by Fukuoka (99%), Osaka (91%), and Aichi (87%). By industry, the ratios for commerce, finance and insurance, transport and postal services, and information and communications have relatively high dependence within Tokyo. The ratios of finance-related sectors are high, while manufacturing sectors including transportation equipment have low dependence within Aichi. When looking at Osaka, the ratios of agriculture, forestry and fishery, and water supply are high, while those in the manufacturing sectors are low. Within a somewhat high trend in Fukuoka, there are sectors with higher dependence than the sectors of Tokyo.

Table 6 The Ratios of Dependence on Inducement Effects Generated by the Outflows of Head Office Sectors

	Tokyo	Aichi	Osaka	Fukuoka
Agriculture, forestry and fishery	99%	54%	129%	157%
Mining	99%	97%	93%	92%
Beverages and Foods	94%	32%	43%	47%
Textile products	91%	42%	46%	63%
Pulp, paper and wooden products	96%	61%	69%	63%
Chemical products	97%	100%	53%	577%
Petroleum and coal products	100%	105%	97%	140%
Plastic and rubber products	96%	38%	60%	93%
Ceramic, stone and clay products	94%	43%	58%	59%
Iron and steel	99%	59%	58%	175%
Non-ferrous metals	99%	86%	87%	95%
Metal products	93%	30%	61%	58%
General-purpose machinery	92%	40%	46%	52%
Production machinery	93%	20%	51%	112%
Business oriented machinery	87%	71%	83%	85%
Electronic components	89%	17%	46%	111%
Electrical machinery	91%	44%	33%	49%
Information and communication electronics equipment	95%	73%	94%	97%
Transportation equipment	96%	17%	77%	29%
Miscellaneous manufacturing products	82%	41%	60%	72%
Construction	101%	74%	93%	130%
Electricity, gas and heat supply	90%	98%	99%	99%
Water supply	100%	0%	124%	66%
Waste maanagement services	88%	34%	59%	185%
Commerce	434%	96%	96%	96%
Finance and insurance	116%	136%	98%	102%
Real estate	87%	193%	66%	109%
Transport and postal services	210%	96%	96%	98%
Information and communications	136%	90%	91%	90%
Public administration	0%	0%	0%	0%
Education and research	98%	66%	64%	188%
Medical, health care and welfare	99%	94%	87%	369%
Miscellaneous non-profit services	1%	36%	40%	35%
Business services	88%	62%	64%	77%
Personal services	94%	61%	83%	157%
Office supplies	0%	0%	0%	0%
Activities not elsewhere classified	0%	0%	0%	0%
Total	114%	87%	91%	99%

4-4 The Specialization Coefficients of Outflows and Total Products of Head Office Sectors

By combining the specialization coefficients of outflows (calculated by

$\frac{\text{industrial proportion ratio of outflows within head office sectors}}{\text{industrial proportion ratio of sum of goods and services sectors and head office sectors}}$) and those of regional products ($\frac{\text{industrial proportion ratio of regional products within head office sectors}}{\text{industrial proportion ratio of sum of goods and services sectors and head office sectors}}$), we can create a typological presentation of the specializations of each industrial sector. As indicated in Figures 3, 4, 5, and 6 by region, the figures of the sectors are plotted on each figure, with the specialization coefficients of regional products on the horizontal axis, and those of outflows on the vertical axis. Each position on figures can reveal the characteristics of the industrial sector by region. The size of each bubble on the figures means the industrial ratio of regional products within the entire head office sector. To simplify, some of industrial sectors are omitted. Sectors plotted under the 45-degree line are more specialized in the regional products of head office sectors than their outflows. Typically, these sectors indicate intra-regional transaction between goods and services sectors and head office sectors are large. Sectors beyond the 45-degree line are more specialized in outflows of head office sectors than regional products of them. Commonly, these sectors depend on inter-regional transactions as head office services. So, manufacturing sectors tend to plot under the 45-degree lines, but service-related sectors tend to plot above the 45-degree lines. In other words, raw materials manufacturing industries, whose intermediate input rate are high, tend to transact actively with corporates located in short distance, while service-related industries tend to develop blanch offices and retail store extensively, which is why inter-regional transactions are active.

Fig. 3 The Specialization Coefficients of Outflows and Total Products of Head Office Sectors in Tokyo

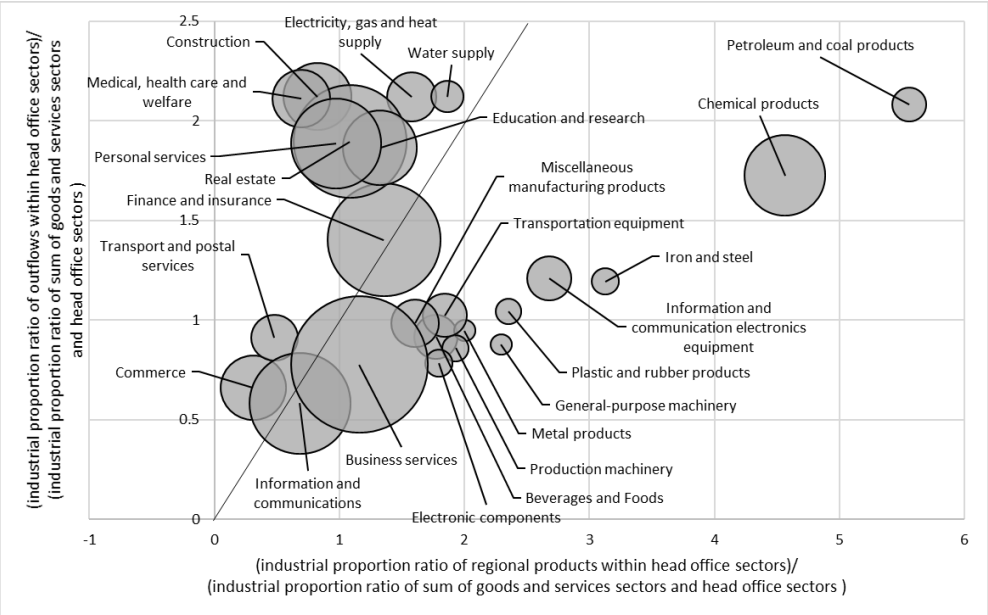


Fig. 4 The Specialization Coefficients of Outflows and Total Products of Head Office Sectors in Aichi

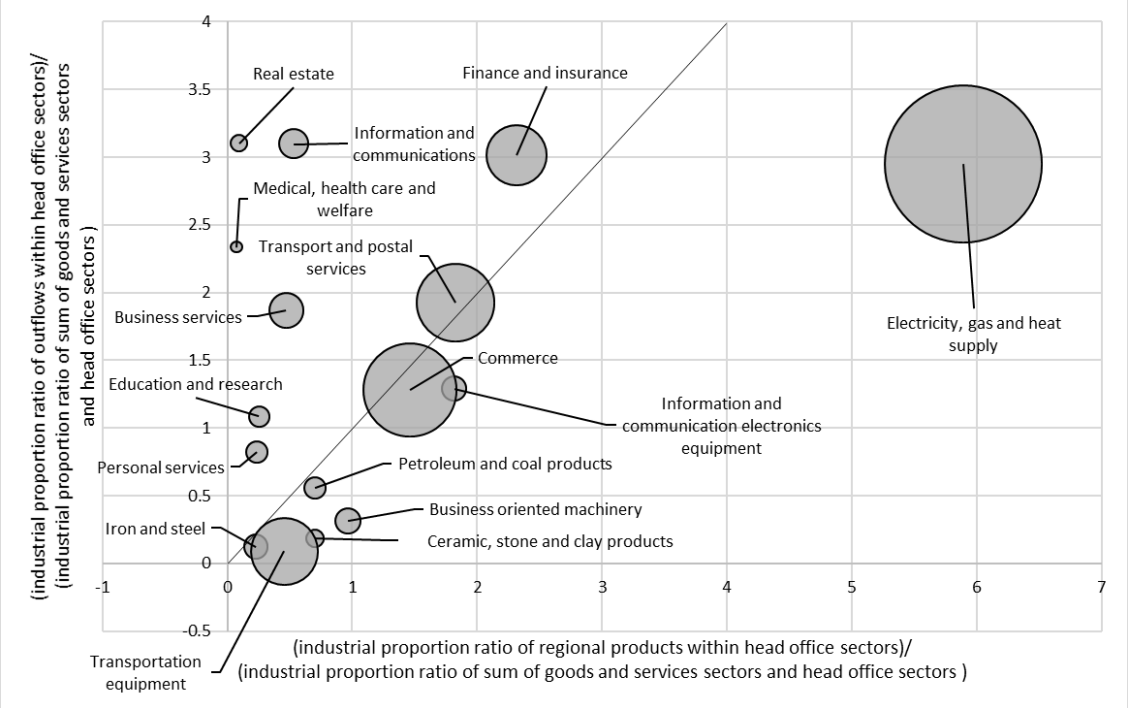


Fig. 5 The Specialization Coefficients of Outflows and Total Products of Head Office Sectors in Osaka

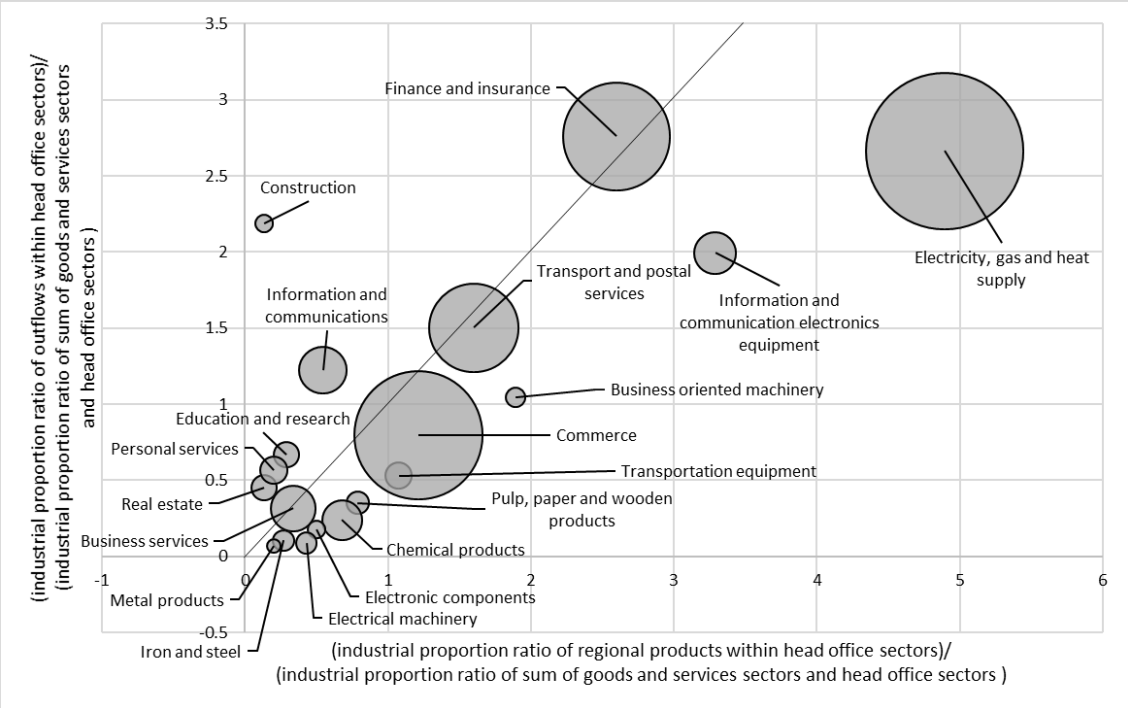
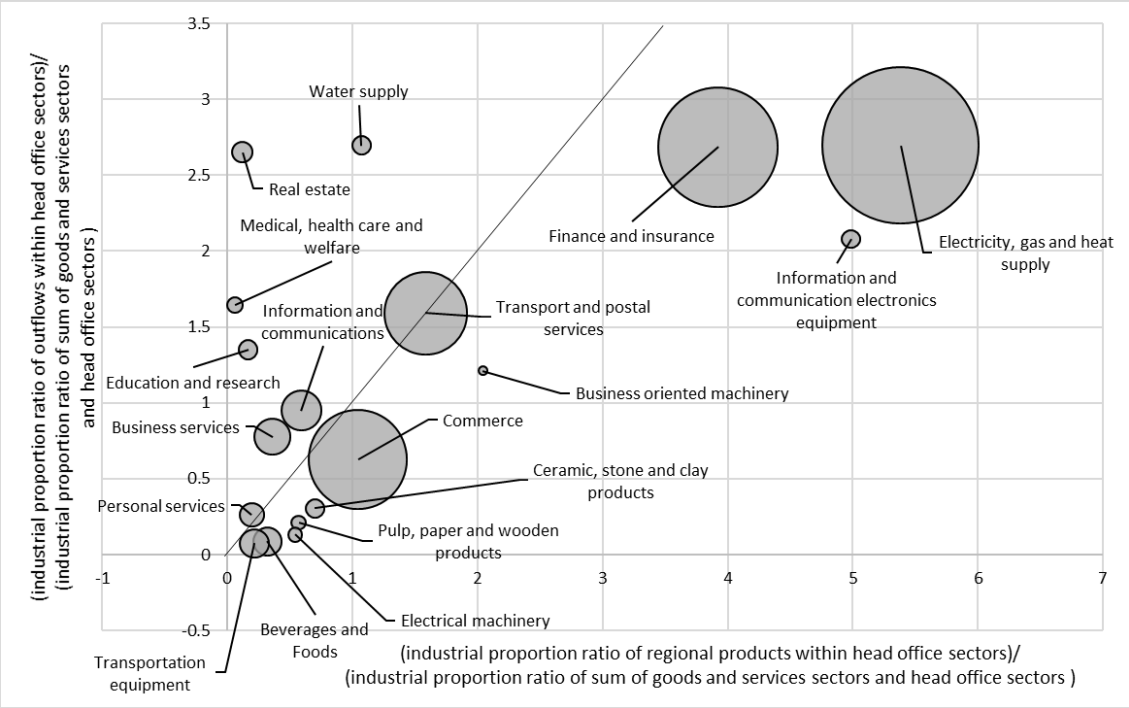


Fig. 6 The Specialization Coefficients of Outflows and Total Products of Head Office Sectors in Fukuoka



4-5 The Hypothetical Extraction Approach

The hypothetical extraction approach can quantify how much the total output of a sector, region, or nation economy would decrease if a particular sector, region, or nation were removed from that economy. This approach can also measure the strength of relationships between the removed sector and that economy from the decrease. Here, we measure how much the regional output would decrease if the outflows of head office sectors by region were as follows:

From (2) above, the outflows which removed head office sectors from e_r is denoted by $\bar{e}_{r(h)}$. Using $\bar{e}_{r(h)}$, output in reduced economy is found as the formula:

$$\bar{x}_{(h)} = \left(I - \left(I - \widehat{M} - \widehat{N}\right)A\right)^{-1}\left(fd + \bar{e}_{r(h)} + e_w\right) \qquad (5)$$

Here, $x - \bar{x}_{(h)}$ is the decrease of the total output if outflows of the head office sectors disappear. Equation (2) before removing head office sectors and equation (5) after removing head office sectors are divided into goods and services sectors (a) and head office sectors (h) respectively, expressing them in matrix as follows:

$$x = \begin{bmatrix} B_{aa} & B_{ah} \\ B_{ha} & B_{hh} \end{bmatrix} \begin{bmatrix} fd & e_{ar} & e_{aw} \\ O & e_{hr} & O \end{bmatrix} \begin{bmatrix} i \\ i \\ i \end{bmatrix} \qquad (6)$$

$$\bar{x}_{(h)} = \begin{bmatrix} B_{aa} & B_{ah} \\ B_{ha} & B_{hh} \end{bmatrix} \begin{bmatrix} fd & e_{ar} & e_{aw} \\ O & O & O \end{bmatrix} \begin{bmatrix} i \\ i \\ i \end{bmatrix} \qquad (7)$$

Here, the summation vector with ones is indicated by i.

Table 7 shows x-$\bar{x}_{(h)}$ as the amount of decrease and $\frac{x-\bar{x}_{(h)}}{x}$ as the rate of decrease. When looking at the amount of decrease of entire industries by region, Tokyo is the largest (31 trillion yen), followed by Osaka (11 trillion yen), Aichi (8 trillion yen), and Fukuoka (5.7 trillion yen). The rate of decrease of entire industries by region shows the highest for Tokyo and Fukuoka at 95%, followed by Osaka (91%) and Aichi (84%). Observing manufacturing sectors, the rate of decrease is more than 90% in Tokyo, while that is low in other regions. The rate of decrease in Aichi is the lowest among these regions, and the outflows of head offices located in Aichi have weak influence on the whole economy of the region.

Table 7 The Results of Hypothetical Extraction Approach

Unit: ¥

	Tokyo		Aichi		Osaka		Fukuoka	
	the amount of decrease	the rate of decrease	the amount of decrease	the rate of decrease	the amount of decrease	the rate of decrease	the amount of decrease	the rate of decrease
Agriculture, forestry and fishery	42,006	99%	4,984	54%	3,060	100%	10,289	100%
Mining	30,286	99%	23,231	97%	3,308	93%	7,181	92%
Beverages and Foods	460,944	94%	32,304	32%	37,989	43%	35,871	47%
Textile products	60,890	91%	8,511	42%	16,496	46%	3,705	63%
Pulp, paper and wooden products	154,194	96%	37,482	61%	59,268	69%	13,808	63%
Chemical products	1,552,846	97%	42,825	100%	142,466	53%	65,748	100%
Petroleum and coal products	311,018	100%	85,728	100%	80,036	97%	29,892	100%
Plastic and rubber products	167,603	96%	43,372	38%	52,422	60%	22,326	93%
Ceramic, stone and clay products	94,359	94%	26,160	43%	10,962	58%	19,850	59%
Iron and steel	195,486	99%	62,576	59%	45,333	58%	32,597	100%
Non-ferrous metals	95,995	99%	17,756	86%	55,257	87%	20,364	95%
Metal products	120,632	93%	7,644	30%	21,834	61%	5,241	58%
General-purpose machinery	112,783	92%	21,209	40%	28,644	46%	7,099	52%
Production machinery	176,717	93%	8,892	20%	21,363	51%	8,158	100%
Business oriented machinery	197,361	87%	83,301	71%	58,753	83%	7,926	85%
Electronic components	178,864	89%	8,465	17%	26,309	46%	12,801	100%
Electrical machinery	255,244	91%	46,947	44%	26,207	33%	11,096	49%
Information and communication electronics equipment	476,832	95%	79,446	73%	269,428	94%	33,465	97%
Transportation equipment	469,042	96%	129,534	17%	92,953	77%	22,500	29%
Miscellaneous manufacturing products	477,250	82%	36,349	41%	81,862	60%	28,900	72%
Construction	1,149,929	100%	35,091	74%	54,494	93%	35,896	100%
Electricity, gas and heat supply	558,931	89%	3,921,290	98%	3,822,285	99%	2,084,644	99%
Water supply	267,742	100%	14,329	100%	14,500	100%	21,180	66%
Waste maanagement services	112,730	88%	3,010	34%	3,762	59%	7,672	100%
Commerce	4,638,104	100%	1,360,092	96%	2,487,783	96%	809,035	96%
Finance and insurance	3,611,018	100%	821,487	100%	1,795,373	98%	1,260,505	100%
Real estate	2,710,768	86%	97,929	100%	74,644	66%	45,180	100%
Transport and postal services	1,139,751	100%	952,041	96%	1,220,328	96%	585,790	98%
Information and communications	3,415,664	100%	134,571	90%	334,177	91%	130,079	89%
Education and research	1,340,250	98%	49,780	66%	72,817	64%	69,690	100%
Medical, health care and welfare	827,522	99%	25,527	94%	41,057	87%	90,566	100%
Miscellaneous non-profit services	1,797	7%	6,813	36%	8,679	40%	5,030	35%
Business services	4,028,757	88%	126,804	61%	219,957	64%	92,473	76%
Personal services	1,869,312	94%	54,147	61%	105,719	83%	87,505	100%
Total	31,302,628	95%	8,409,628	84%	11,389,523	91%	5,724,061	95%

When looking at the dependence of entire industries on headquarter functional activities by region, Tokyo is high, while Aichi is relatively low. By industry, the same finding is obtained from manufacturing industries, while service-related industries commonly depend on them. That means manufacturing industries and establishments engaged in direct production activities relocate in other regions, and establishments engaged in indirect management activities remain in Tokyo. In addition, the direct production activities of Aichi remain there, so the regional economy does not depend on headquarter functional activities in the case of Aichi.

4-6 The Respective Inducement Effects Generated by Outflows of Head Office Sectors by Area

As stated in 4-1, "$B_{ah}e_{hr} + B_{hh}e_{hr}$" is obtained by region. Table 8 shows the top 10 regions in terms of the amount of inducement effects generated by the outflows of head office sectors. According to this table, these regions can be classified into metropolitan areas, Tokai area, Kansai area, and Kyusyu area. For example, Tokyo corresponds to the metropolitan area, Aichi corresponds to the Tokai area, Osaka corresponds to the Kansai area, and Fukuoka corresponds to the Kyusyu area. Hence, Tokyo, Aichi, Osaka, and Fukuoka seem to establish economic areas. Establishing this point is the research task.

Table 8 Top 10 Regions for Inducement Effects Generated by Outflows of Head Office Sectors

Unit: ¥

	Tokyo		Aichi		Osaka		Fukuoka	
1	Kanagawa	6,218,210	Shizuoka	2,433,649	Hyogo	3,103,889	Kumamoto	1,091,702
2	Osaka	5,259,293	Gifu	2,112,079	Tokyo	2,028,788	Saga	1,090,313
3	Saitama	3,748,849	Mie	1,926,007	Kyoto	1,513,084	Oita	1,071,022
4	Chiba	3,252,916	Nagano	1,396,888	Fukui	933,148	Kagoshima	1,030,503
5	Aichi	2,960,758	Tokyo	1,335,336	Nara	879,287	Nagasaki	1,000,987
6	Fukuoka	1,906,292	Osaka	500,793	Shiga	831,231	Miyazaki	753,804
7	Hokkaido	1,520,018	Kanagawa	276,032	Wakayama	751,844	Tokyo	443,431
8	Ibaraki	1,479,563	Saitama	212,326	Aichi	718,185	Yamaguchi	269,890
9	Shizuoka	1,469,097	Shiga	185,183	Fukuoka	505,599	Chiba	214,857
10	Hyogo	1,436,651	Chiba	174,879	Kanagawa	467,407	Osaka	182,161

5. Conclusion

In this paper, we estimate 37 head office sectors in each intra-regional I-O table in Tokyo, Aichi, Osaka, and Fukuoka and separate exports for other regions (herein we refer to this as

"outflows") of the head office sectors by prefecture. Moreover, we analyzed the inter-regional relationships between the head offices located in these four regions and the dependence of these regional economy on headquarter functional activities.

The inter-regional relationships among Tokyo, Aichi, Osaka, and Fukuoka regarding headquarter functional activities can be regarded as a hierarchical structure, as Tokyo—Osaka—Aichi—Fukuoka. In addition, the transaction between Tokyo and Osaka is relatively intensive. We also find that the head offices located in Tokyo tend to obtain large profit by providing head office services to Osaka.

When looking at the dependence of entire industries on headquarter functional activities by region, Tokyo is high, while Aichi is low relatively as well as limiting manufacturing industries. That means that establishments engaged in direct production activities relocate in other regions, and establishments engaged in indirect management activities remain in Tokyo. In addition, direct production activities of Aichi remain there, so the regional economy does not depend on headquarter functional activities in the case of Aichi.

It is necessary to examine the inter-regional transactions of headquarter functional activities among not only Tokyo, Aichi, Osaka, and Fukuoka, but also all 47 prefectures. With respect to the amount of inducement effects generated by outflows of head office sectors, Tokyo, Aichi, Osaka, and Fukuoka seem to establish economic areas, metropolitan areas, Tokai area, Kansai area, and Kyusyu area respectively. Suhara and Ishiro (2019) analyze headquarter functional activities quantitatively of the Kanto region, including the metropolitan area. Ideally, the headquarter functional activity of each economic area should be analyzed quantitatively, such as the head offices of Aichi within the Tokai area, those of Osaka within the Kansai area, and those of Fukuoka within the Kyusyu area. By adding the analysis of each economic area to the hierarchical structure (Tokyo—Osaka—Aichi—Fukuoka) obtained in this paper, we can examine the problems related to the extreme concentration in Tokyo, such as the whole hierarchical structure and hierarchical national economic system.

In this paper, we estimate the head office sectors in each intra-regional I-O table in 2011. Ishida (1990) and others described the significance of compilation as "inter-regional" (not "intra-regional") I-O tables, because headquarter functional activities as intermediate goods are directly combined with the production activities of the goods and services sectors in other regions.

Therefore, the research task is to analyze Japan's whole headquarter functional activities quantitatively by separating them into economic areas and to compile "inter-regional" I-O tables recording 37 head office sectors.

Declarations

Availability of data and materials: The author used publicly available data and materials.
Competing interests: The author declare that have no competing interests.
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Authors' contributions: The author contributed to the drafting of all sections of the paper.
Acknowledgements: This paper represents the personal opinions.

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Figures

		Intermediate Demand		Regional Final-Demand	Outflows	(less) Inflows	Regional Products
		Goods and Services Sectors	Head Offices Sectors				
Interme-diate Input	Goods and Services Sectors	D	Z	P	K	O	X
	Head Offices Sectors	D*			K*	O*	X*
Gross Value Added		V	V*				
Regional Products		X	X*				

Figure 1

The Conceptual Chart of This Estimation (Aichi, Osaka, and Fukuoka)

		Intermediate Demand		Regional Final-Demand	Outflows	(less) Inflows	Regional Products
		Goods and Services Sectors	Head Offices Sectors				
Interme-diate Input	Goods and Services Sectors	D	Z	P	K	O	X
	Head Offices Sectors	D*			K*	O*	X*
Gross Value Added		V	V*				
Regional Products		X	X*				

Figure 2

The Conceptual Chart of This Estimation (Tokyo)

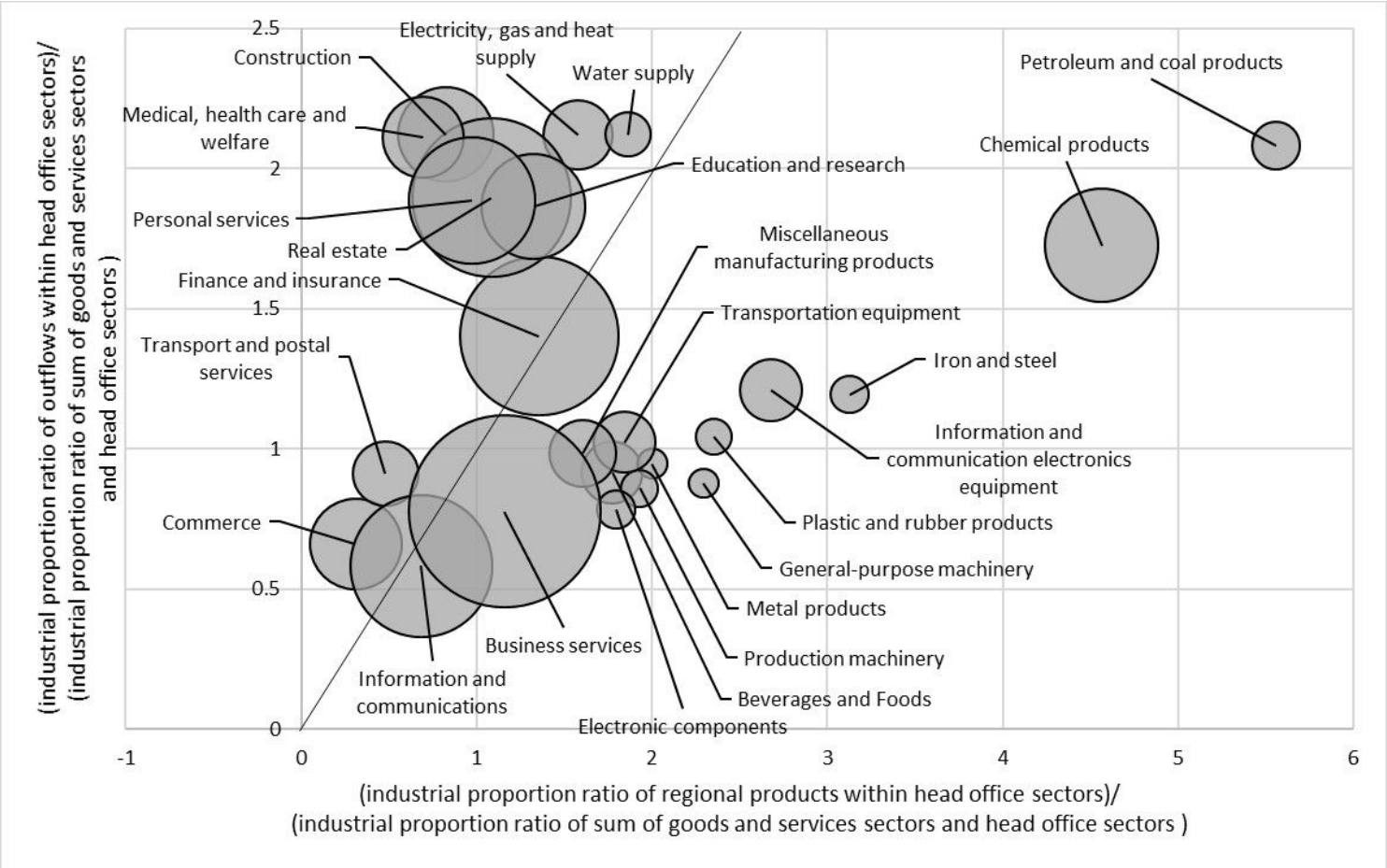

Figure 3

The Specialization Coefficients of Outflows and Total Products of Head Office Sectors in Tokyo

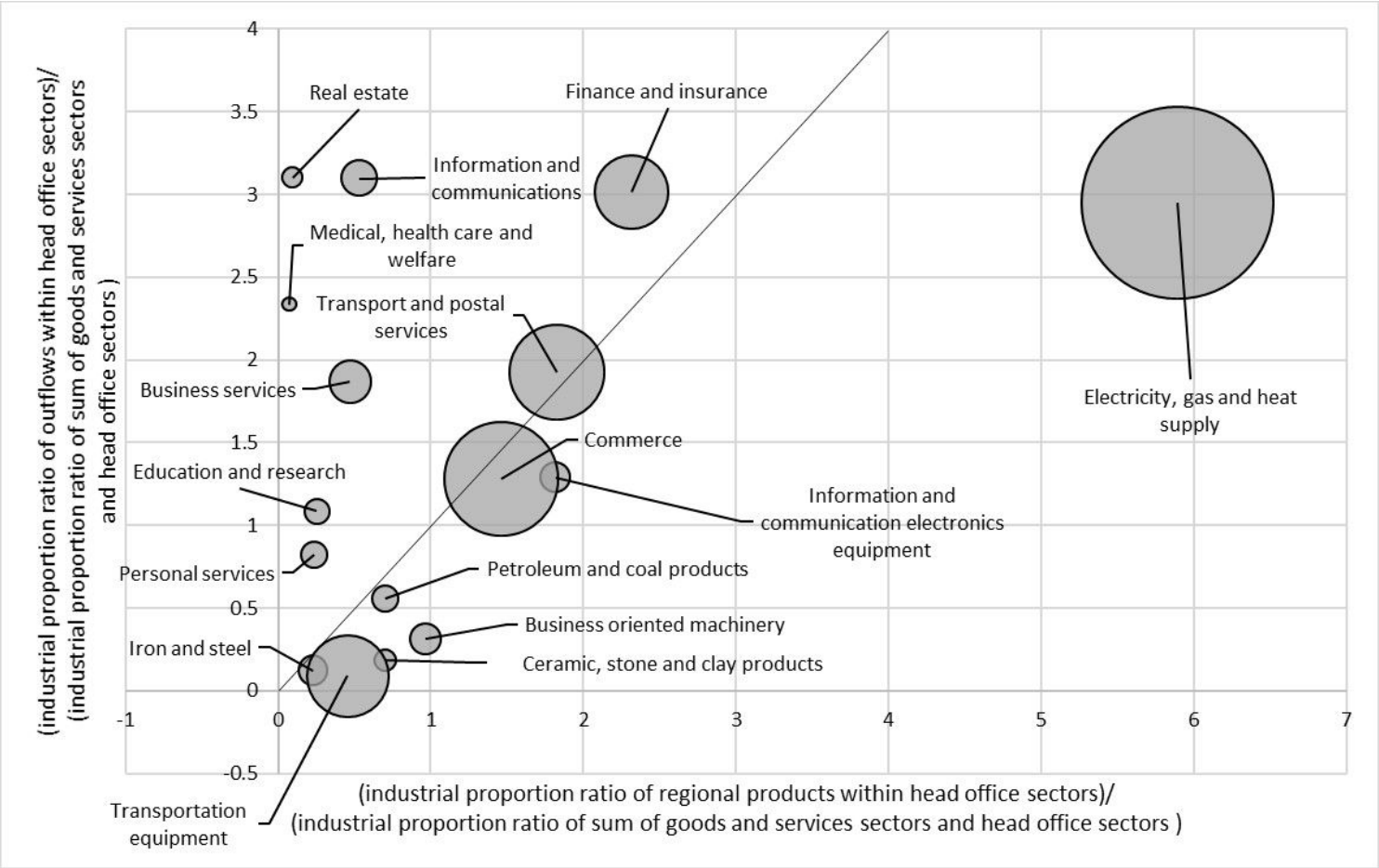

Figure 4

The Specialization Coefficients of Outflows and Total Products of Head Office Sectors in Aichi

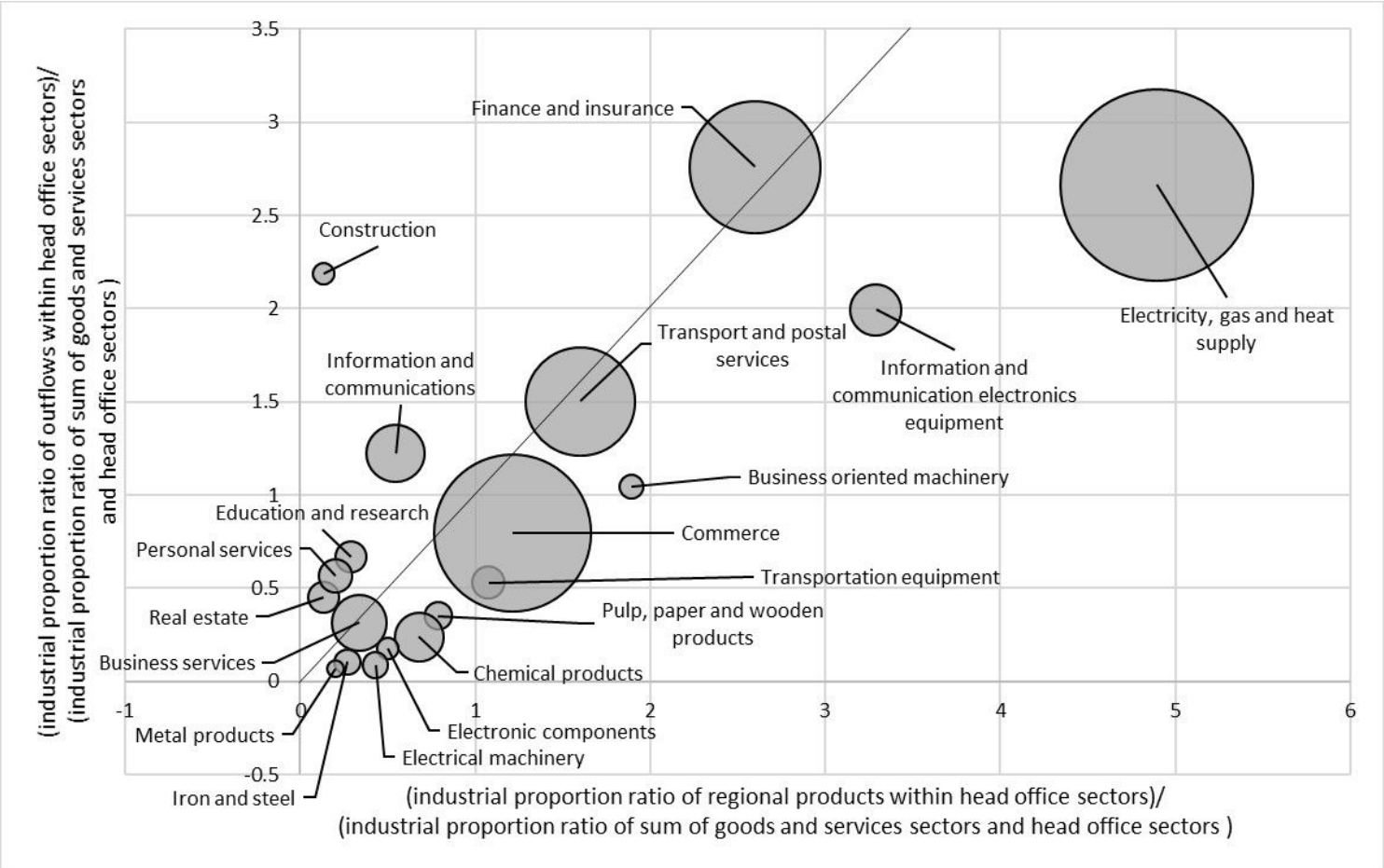

Figure 5

The Specialization Coefficients of Outflows and Total Products of Head Office Sectors in Osaka

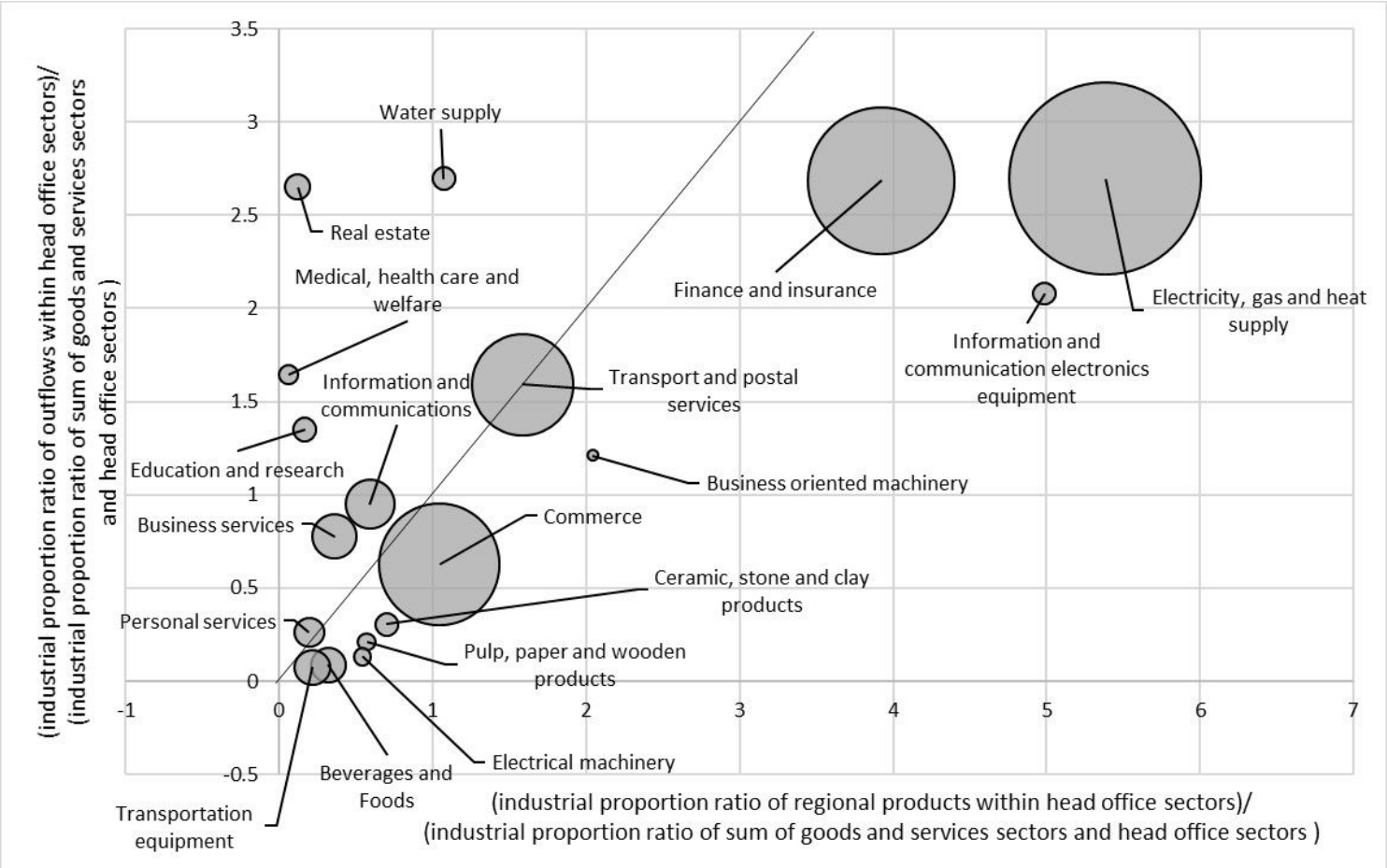

Figure 6

The Specialization Coefficients of Outflows and Total Products of Head Office Sectors in Fukuoka

Supplementary Files

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- Additionalfile1.xlsx