The Roles of Agricultural Industries in Japan: An Economic Analysis

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Abstract

The purpose of this study is to analyze the roles of agricultural industries in the Japanese national economy. This study employs Input-Output (IO) analysis as an analysis tool. More specifically, this study utilizes the parts of IO analysis, namely simple output multiplier, simple household income multiplier, index of the power of dispersion, and index of the sensitivity of dispersion as analysis apparatuses. The analysis period of this study is 1985-2005. In this study, the analyzed sectors are crop cultivation and agricultural services. The results show that, by using both multipliers, the analyzed agricultural industries did not include in the top five Japanese industrial sectors from 1985 through 2005. By using both indices, one can claim that agricultural services sector lied in quadrant III on the analysis period. Meanwhile, crop cultivation industry lied in quadrant II from 1985 through 1995 while it moved to quadrant III afterwards. Based on these quadrant positions, one can argue that the analyzed industries had weak impacts on the whole Japanese industries on the analysis period.

Keywords
Agricultural Industries, National Economy, IO Analysis, Impacts.

1. Introduction

The industrial sectors are important aspects in a national economy. Their contributions can be observed not only on the micro aspect, but also on the macro aspect of a country. Also, their important roles can be seen both in developed and developing countries. One of the industrial sectors that worth to be discussed in this matter is the agricultural industry.

There are many previous studies discuss the agricultural aspect. For example, Akinwehinmi et al. (2021) analyze the impact of consumers' Food Control Risk Perception (FCRP) on preference for food safety attributes with a special focus on three certification choices, namely (1) government-controlled, (2) Participatory Guarantee System (PGS)-driven, and (3) foreign certification. One of the points that is noticed in their study is consumers' awareness of organic agriculture. As a case for their study, they utilize choice experimental data from Nigeria. Engemann et al. (2022) analyze the role of exporters' Institutional Quality (IQ) and its similarity with importers' IQ in the constancy of trade

links. They focus on the trade links of agri-food products exported from sub-Saharan African (SSA) nations to the European Union (EU-28) and consider three scopes of IQ, namely (1) government selection, monitoring, and replacement, (2) efficiency of policy construction and execution, (3) and respect of people and state for institutions.

Meanwhile, the study of Myrna (2022) contributes to a rare body of literature related to the existence of bidding errors in agricultural land auctions. Zossou et al. (2022) assess the combined impact of exogenous and endogenous information on urban Beninese consumers' evaluation of locally produced upgraded parboiled rice relative to imported rice. Traore et al. (2021) define empirical proof of the agricultural industry's contribution to the development of Burkina Faso's people well-being.

On the other hand, Gu and Wang (2020) investigate the effect of the pandemic on vegetable production and offers recommendations on agricultural insurance via a survey and interviews with 46 agricultural cooperatives in Shanghai. Akhtar et al. (2019) utilize primary data of 400 hybrid maize growers from rural Punjab in Pakistan to find the simultaneous adoption of off-farm income discrepancy and agricultural credit. Lin and Zhang (2020) analyze the influence of COVID-19 on agricultural export corporations in China using a unique firm-level survey data.

Based on the aforesaid previous studies, one can argue that the study to analyze the economic aspect of the agricultural industry in other Asian countries is still needed. This study is conducted to fulfill the gap. One of the apparatuses in conducting the analysis is Input-Output (IO) analysis, the device in examining the linkages of industrial sectors in one or more countries. The importance and originality of this study are that it explores the roles of the agricultural industry by using several calculation methods from IO analysis which focusing on the Japanese national economy.

The purpose of this study is to analyze the roles of agricultural industries in the national economy of Japan. This study employs IO analysis as an analysis tool. More specifically, this study utilizes the parts of IO analysis, namely simple output multiplier, simple household income multiplier, index of the power of dispersion, and index of the sensitivity of dispersion as analysis apparatuses. The analysis period of this study is 1985-2005.

The rest of this paper is clarified as follows. Section 2 explains the methodology of this study. Section 3 defines the results of calculations. Also, the discussions for the results can be observed on this section. The next section, section 4, elucidates the conclusions of this study and suggested further research.

2. Methodology

The methodology of this study is elucidated as follows. The first step is to define the data used. This study uses Japanese IO tables for 1985, 1990, 1995, 2000, and 2005 as data. Initially, the tables consist of 84, 91, 93, 104, and 108 industrial sectors, respectively. After performing the adjustment process, the tables have 78 industrial sectors. Those industries are showed in Appendix. The second step is to display the Japanese agricultural industries used in this study. Table 1 explains those industries.

Table 1. Japanese Agricultural Industries Used in This Study

Sector Number	Sector Name
1	Crop cultivation
3	Agricultural services

The third step is to perform the calculations by employing simple output multiplier and simple household income multiplier. Miller and Blair (2009) explain the equations of both multipliers as follows:

$$m(o)_j = \sum_{i=1}^{n} l_{ij} \quad (1)$$

$$m(h)_j = \sum_{i=1}^{n} a_{n+1}\, l_{ij}. \quad (2)$$

The former model defines the simple output multiplier while the latter one elucidates the simple household income multiplier. More specifically, $m(o)_j$, $m(h)_j$, $a_{n+1,i}$, n, and l_{ij} are simple output multiplier for sector j, simple household

income multiplier for sector *j*, the coefficients of labor-input, the number of analyzed industrial sectors, and a sector-to-sector multipliers matrix, respectively.

The next step is to perform the calculations in order to analyze the characteristics of Japanese industries on the period of analysis, especially the Japanese agricultural industries. The methods used in the calculations are index of the power of dispersion and index of the sensitivity of dispersion. The former index is applied to investigate the strength of one specific industry in influencing entire industries. A larger influence is aligned with the higher index value. The detail of the index is clarified by Ministry of Internal Affairs and Communications Japan (n.d.) as follows:

$$\text{Index of the power of dispersion by sector} = \frac{b_{*j}}{\bar{B}}. \quad (3)$$

The numerator is each sum of column in the table of inverse matrix coefficients while the denominator elucidates the mean value of the entire vertical sum in the table of inverse matrix coefficients. More specifically, the equations of numerator and denominator are defined as follows:

$$b_{*j} = \sum_i^n b_{ij} \quad (4)$$

$$\bar{B} = \frac{1}{n}\sum_j b_{*j} = \frac{1}{n}\sum_i \sum_j b_{ij}. \quad (5)$$

Further, b_{ij} and n are the value of Leontief inverse from sector i to sector j and total number of analyzed industrial sectors, respectively. The latter index is applied to analyze the sensitivity of the particular industrial sector to the external influences. A larger sensitivity is aligned with the greater index value. More specifically, one specific industrial sector is called more sensitive to the impacts from the external aspects if it has a higher index value. The detail of the index is explained by Ministry of Internal Affairs and Communications Japan (n.d.) as follows:

$$\text{Index of the sensitivity of dispersion by sector} = \frac{b_{i*}}{\bar{B}}. \quad (6)$$

In this index, the numerator is each sum of row in the table of inverse matrix coefficients while the denominator defines the mean value of the entire horizontal sum in the table of inverse matrix coefficients. Further, the equations of the numerator and denominator of the index are clarified as follows:

$$b_{i*} = \sum_j^n b_{ij} \quad (7)$$

$$\bar{B} = \frac{1}{n}\sum_i b_{i*} = \frac{1}{n}\sum_i \sum_j b_{ij}. \quad (8)$$

In order to get a compatibility sense with the previous index, equation (7) is slightly altered from the original source. More specifically, the part defines the total number of discussed industrial sectors, n, is added into the equation. As with the previous description, b_{ij} is the Leontief inverse value from sector i to sector j. Conclusions of the study and suggested further researches are elucidated on the last step.

3. Results and Analysis

Tables 2, 3, 4, 5, and 6 show the top five Japanese industrial sectors viewed from the value of simple output multiplier in 1985, 1990, 1995, 2000, and 2005, respectively. Miller and Blair (2009) elucidate that an output multiplier for sector *j* is the total value of production in all industrial sectors of the economy that is required in order to accomplish a currency's worth of final demand for the output of sector *j*. They also define that, for the simple output multiplier, the total value of production is coming from the households exogenous model.

Analyzed agricultural industries do not include in the tables. By using this result, one can say that the industries did not make the attractive impact to the economy of Japan on the analysis period through an additional final demand. The other interesting fact from the multiplier is the industry number 36, steel products, can be seen in the tables. This fact elucidates the consistency of the industry in attracting the Japanese economy from 1985 through 2005. The same phenomenon can be observed on the sector 65, self-transport by private cars. The other interesting phenomenon is the sector number 47, motor vehicles and repair of motor vehicles, occupies the first position in almost all tables. For

example, the sector occupies the first rank in table 5 which the value is 3.112. This result clarifies that in order to satisfy a yen's worth of final demand for the sector's output in 2005, all Japanese industries required to produce the products which the total value was ¥3.112.

Table 2. Top Five Japanese Industrial Sectors Viewed from the Value of Simple Output Multiplier, 1985 (Source: Zuhdi et al. (2021))

No.	Sector Number	Sector Name	Simple Output Multiplier
1	36	Steel products	3.456
2	65	Self-transport by private cars	3.283
3	23	Synthetic resins	3.266
4	22	Chemical basic and intermediate products	3.197
5	35	Pig iron and crude steel	3.183

Table 3. Top Five Japanese Industrial Sectors Viewed from the Value of Simple Output Multiplier, 1990 (Source: Zuhdi et al. (2021))

No.	Sector Number	Sector Name	Simple Output Multiplier
1	47	Motor vehicles and repair of motor vehicles	3.104
2	36	Steel products	3.097
3	65	Self-transport by private cars	2.852
4	35	Pig iron and crude steel	2.850
5	23	Synthetic resins	2.805

Table 4. Top Five Japanese Industrial Sectors Viewed from the Value of Simple Output Multiplier, 1995 (Source: Zuhdi et al. (2021))

No.	Sector Number	Sector Name	Simple Output Multiplier
1	47	Motor vehicles and repair of motor vehicles	3.063
2	36	Steel products	2.887
3	65	Self-transport by private cars	2.748
4	11	Feeds and organic fertilizer, n.e.c.	2.717
5	35	Pig iron and crude steel	2.672

Table 5. Top Five Japanese Industrial Sectors Viewed from the Value of Simple Output Multiplier, 2000 (Source: Zuhdi et al. (2021))

No.	Sector Number	Sector Name	Simple Output Multiplier
1	47	Motor vehicles and repair of motor vehicles	3.112
2	36	Steel products	2.967
3	23	Synthetic resins	2.916
4	22	Chemical basic and intermediate products	2.882
5	65	Self-transport by private cars	2.820

Table 6. Top Five Japanese Industrial Sectors Viewed from the Value of Simple Output Multiplier, 2005 (Source: Zuhdi et al. (2021))

No.	Sector Number	Sector Name	Simple Output Multiplier
1	47	Motor vehicles and repair of motor vehicles	3.449
2	23	Synthetic resins	3.302
3	22	Chemical basic and intermediate products	3.296
4	36	Steel products	3.237
5	65	Self-transport by private cars	2.952

Figures 1 and 2 show the simple output multiplier values of analyzed industrial sectors on the analysis period. Generally, those industrial sectors have different patterns based on the figures. More specifically, crop cultivation sector had the increasing pattern from 1985 through 2005 while agricultural services sector had the opposite one on the same period.

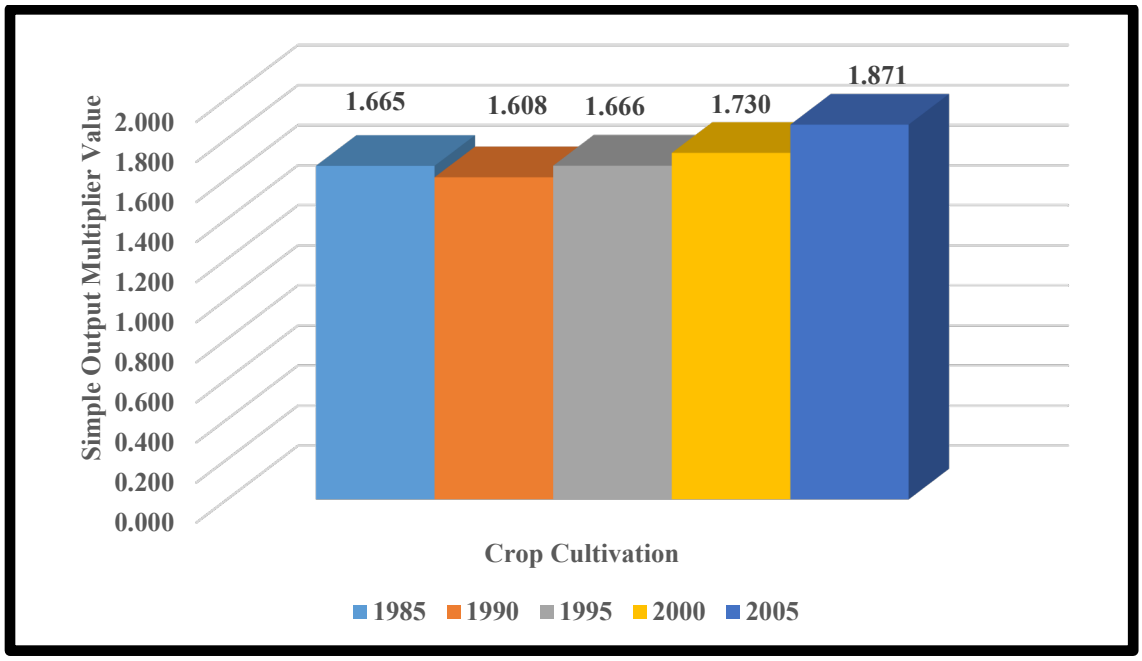

Figure 1. The Simple Output Multiplier Values of the Crop Cultivation Sector, 1985-2005

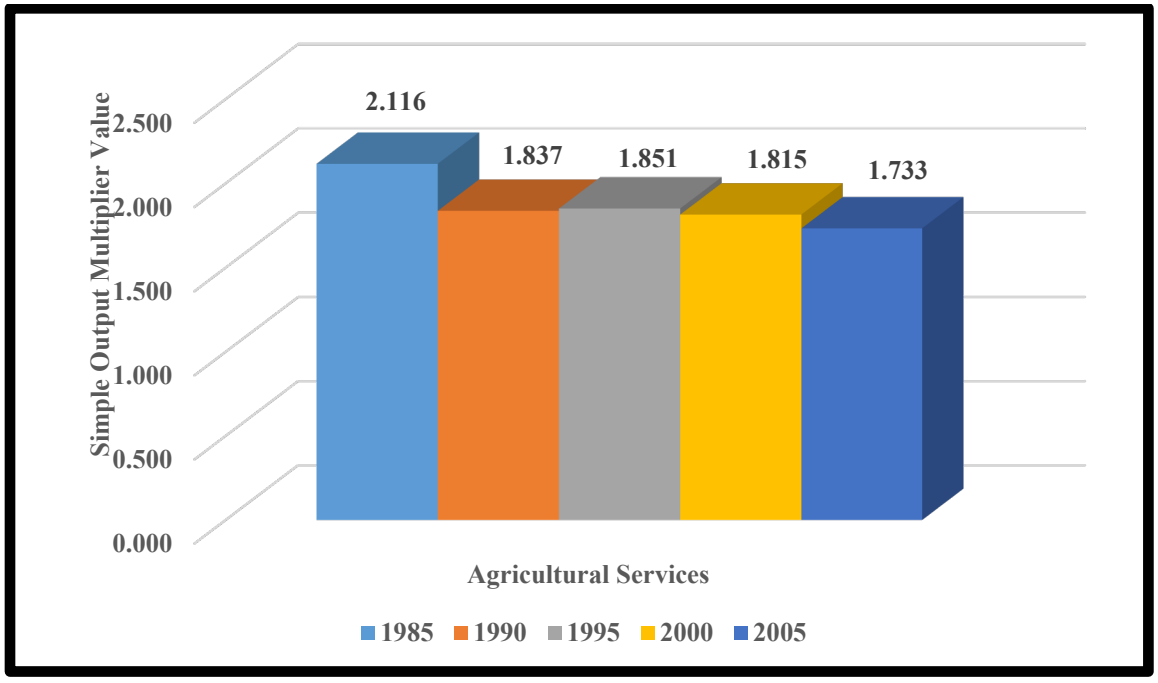

Figure 2. The Simple Output Multiplier Values of the Agricultural Services Sector, 1985-2005

Tables 7, 8, 9, 10, and 11 define the top five Japanese industrial sectors viewed from the values of simple household income multiplier in 1985, 1990, 1995, 2000, and 2005, respectively. Miller and Blair (2009) define that the multiplier is used to clarify the economic influences of new final demand as measured by new households income by using the households exogenous model. The compositions of the tables are not same with the ones of the tables of the previous multiplier.

Table 7. Top Five Japanese Industrial Sectors Viewed from the Value of Simple Household Income Multiplier, 1985 (Source: Zuhdi et al. (2021))

No.	Sector Number	Sector Name	Simple Household Income Multiplier
1	63	Railway	0.848
2	73	Education	0.836
3	64	Road transport (except transport by private cars)	0.736
4	58	Waste management service	0.719
5	72	Public administration and activities not elsewhere classified	0.691

Table 8. Top Five Japanese Industrial Sectors Viewed from the Value of Simple Household Income Multiplier, 1990 (Source: Zuhdi et al. (2021))

No.	Sector Number	Sector Name	Simple Household Income Multiplier
1	73	Education	0.833
2	58	Waste management service	0.739
3	64	Road transport (except transport by private cars)	0.720
4	72	Public administration and activities not elsewhere classified	0.719
5	76	Other public services	0.709

Table 9. Top Five Japanese Industrial Sectors Viewed from the Value of Simple Household Income Multiplier, 1995 (Source: Zuhdi et al. (2021))

No.	Sector Number	Sector Name	Simple Household Income Multiplier
1	73	Education	0.838
2	72	Public administration and activities not elsewhere classified	0.723
3	76	Other public services	0.721
4	64	Road transport (except transport by private cars)	0.720
5	74	Research	0.706

Table 10. Top Five Japanese Industrial Sectors Viewed from the Value of Simple Household Income Multiplier, 2000 (Source: Zuhdi et al. (2021))

No.	Sector Number	Sector Name	Simple Household Income Multiplier
1	73	Education	0.795
2	74	Research	0.715
3	76	Other public services	0.712
4	64	Road transport (except transport by private cars)	0.709
5	75	Medical service, health and social security	0.688

Table 11. Top Five Japanese Industrial Sectors Viewed from the Value of Simple Household Income Multiplier, 2005 (Source: Zuhdi et al. (2021))

No.	Sector Number	Sector Name	Simple Household Income Multiplier
1	73	Education	0.780
2	76	Other public services	0.716
3	64	Road transport (except transport by private cars)	0.684
4	75	Medical service, health and social security	0.676
5	74	Research	0.658

One of the interesting points from the second multiplier is two industries include in the tables, namely road transport (except transport by private cars) and education. In 2000, the values of those industrial sectors were 0.709 and 0.795, respectively. These values indicate that, in 2000, an additional yen of final demand for the industries would generate ¥0.709 and ¥0.795 of new household incomes, respectively, when all direct and indirect impacts were altered into yen estimates of incomes. The other interesting point is the analyzed agricultural industries do not include in the tables. This fact is same with the calculation results of the previous multiplier.

Figures 3 and 4 explain the simple household income multiplier values of analyzed industries on the period of analysis. As with the previous multiplier, those industrial sectors have different patterns on the second one too. More specifically, based on the figures, crop cultivation sector had the increasing pattern from 1985 through 2005 while agricultural services sector had the increasing-decreasing movement on the same period.

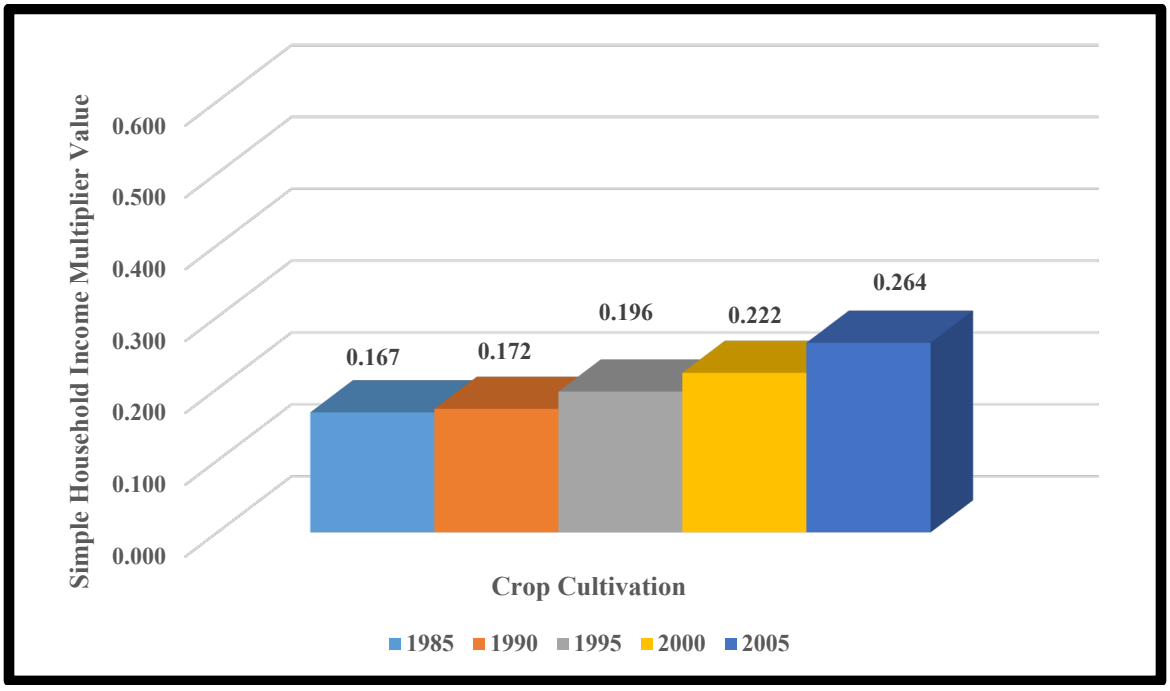

Figure 3. The Simple Household Income Multiplier Values of the Crop Cultivation Sector, 1985-2005

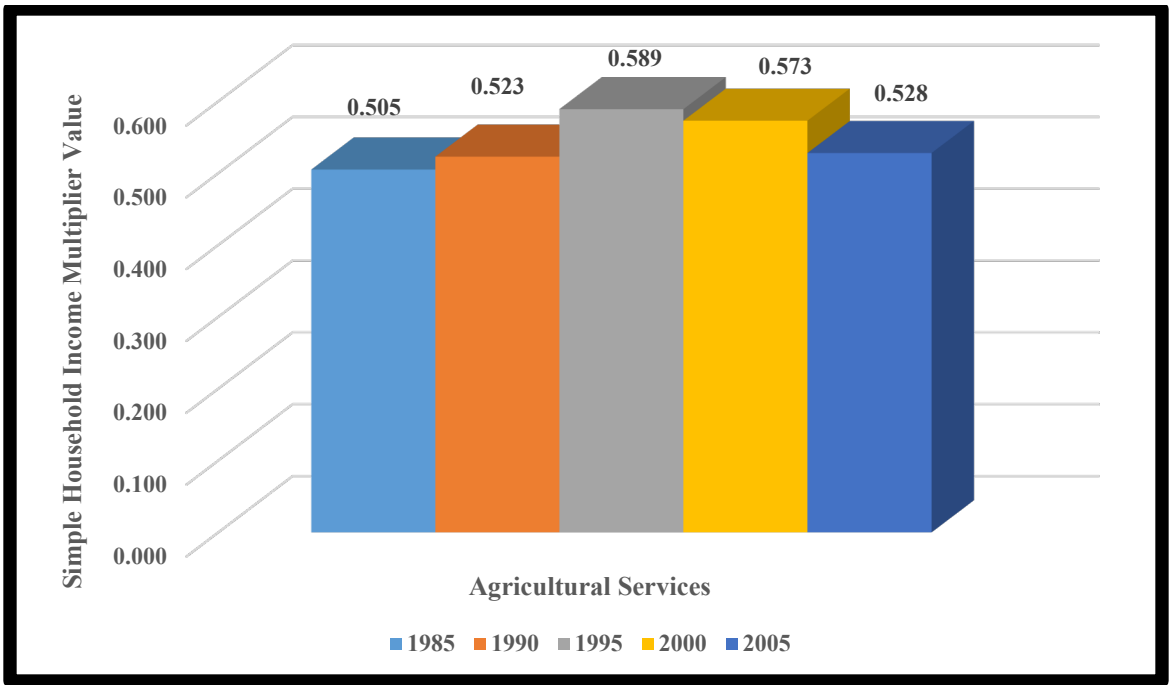

Figure 4. The Simple Household Income Multiplier Values of the Agricultural Services Sector, 1985-2005

Table 12 recapitulates the quadrants of analyzed industries on the analysis period. The quadrants come from the combination of both indices applied in this study, namely the index of the power of dispersion and the index of the sensitivity of dispersion. Four quadrants are generated from the combination.

Each quadrant has unique characteristics. More specifically, quadrant I is a position where the values of both indices are more than one. In other words, the industries lie in this quadrant are those most influenced by the external aspects as well as have strong impacts on the entire industries. The opposite phenomena can be observed on the industries which lie in quadrant III. On the other hand, quadrant II is a location where the value of the index of the power of dispersion is less than one while the value of the other index is more than one. One can argue that the industries lie in this quadrant are those which have weak influences on the entire industries, but they get high impacts from the changes of external aspects. The opposite characteristics are owned by the industrial sectors which lie in quadrant IV.

Table 12. The Quadrants of Japanese Agricultural Sectors, 1985-2005

Sector Number	Sector Name	Quadrant				
		1985	1990	1995	2000	2005
1	Crop cultivation	II	II	II	III	III
3	Agricultural services	III	III	III	III	III

Based on the information in the table, agricultural services sector lied in quadrant III on the analysis period. On the other hand, crop cultivation industry lied in quadrant II from 1985 through 1995 while it moved to quadrant III afterwards. These facts explain that the analyzed industries had weak influences on the entire Japanese industries on the period of analysis.

4. Conclusions and Further Researches

This study investigates the roles of Japanese agricultural industries in the Japanese national economy by using IO analysis. More specifically, this study employs simple output multiplier, simple household income multiplier, index of the power of dispersion, and index of the sensitivity of dispersion as analysis tools. The analysis period of this study is 1985-2005. The analyzed Japanese agricultural sectors in this study are crop cultivation and agricultural services.

The results show that, by using both multipliers, the analyzed agricultural industries did not include in the top five Japanese industrial sectors from 1985 through 2005. By using both indices, one can claim that agricultural services sector lied in quadrant III on the period of analysis. Meanwhile, crop cultivation industry lied in quadrant II from 1985 through 1995 while it moved to quadrant III afterwards. These quadrant positions clarify that the analyzed industries had weak impacts on the whole Japanese industries on the period of analysis.

The understanding regarding the roles of Japanese agricultural industries in impacting the Japanese national economy on the period of analysis is gotten from the current study. However, the study would gain a broader perception about the roles if the study could utilize the longer analysis period. Therefore, as one of the further studies, the study suggests the same analysis by utilizing the longer period of analysis, such as from 1985 through 2015. One of the important aspects that must be considered when conducting the suggested further study is the prices and industrial sectors used on the analyzed IO tables should be same.

The other suggested further research from the study is to do an international comparison using the same methods. The comparison can be focused on developed-developed, developed-developing, or developing-developing countries. The comparison might explore the roles of the agricultural sectors of compared nations so the similarities and differences among those regarding the industries can be investigated. One of the examples of the suggested further research is the comparison between Japan and Indonesia.

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Appendix

The Japanese Industries (Source: Zuhdi et al. (2014) with Slight Modifications)

Sector Number	Sector Name
1	Crop cultivation
2	Livestock
3	Agricultural services
4	Forestry
5	Fisheries
6	Metallic ores
7	Non-metallic ores
8	Coal mining, crude petroleum, and natural gas
9	Foods
10	Beverage
11	Feeds and organic fertilizer, n.e.c.
12	Tobacco
13	Textile products
14	Wearing apparel and other textile products
15	Timber and wooden products
16	Furniture and fixtures
17	Pulp and paper
18	Paper products

19	Publishing and printing
20	Chemical fertilizer
21	Basic industrial inorganic chemicals
22	Chemical basic and intermediate products
23	Synthetic resins
24	Synthetic fibers
25	Final chemical products, n.e.c.
26	Petroleum refinery products
27	Coal products
28	Plastic products
29	Rubber products
30	Leather, fur skins, and miscellaneous leather products
31	Glass and glass products
32	Cement and cement products
33	Pottery, china, and earthenware
34	Other ceramic, stone, and clay products
35	Pig iron and crude steel
36	Steel products
37	Steel castings and forgings, and other steel products
38	Non-ferrous metals
39	Non-ferrous metal products
40	Metal products for construction and architecture
41	Other metal products
42	General industrial machinery
43	Special industrial machinery
44	Other general machines
45	Machinery for office and service industry
46	Electrical appliance
47	Motor vehicles and repair of motor vehicles
48	Ships and repair of ships
49	Other transportation equipment and repair of transportation equipment
50	Precision instruments
51	Miscellaneous manufacturing products
52	Building construction
53	Repair of construction
54	Civil
55	Electricity
56	Gas and heat supply
57	Water supply
58	Waste management service
59	Commerce
60	Finance and insurance

61	Real estate agencies and rental services
62	House rent
63	Railway
64	Road transport (except transport by private cars)
65	Self-transport by private cars
66	Water transport
67	Air transport
68	Storage facility service
69	Services relating to transport
70	Communication
71	Broadcasting
72	Public administration and activities not elsewhere classified
73	Education
74	Research
75	Medical service, health, and social security
76	Other public services
77	Business and office supplies
78	Personal services