VERIFICATION OF THE SMILE CURVE IN THE FOOD INDUSTRY IN JAPAN - A CONSIDERATION USING THE B-TO-B RATE AND OPERATING INCOME MARGIN

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ABSTRACT
The goal of this study is to verify the correlation between the industrial organisation and the profitability of the food industry in Japan. Our analysis shows the profitability of each upstream, midstream, and downstream industry using the concept of the smile curve. A quantitative analysis was performed using the B-to-B rate and operating income margins of 32 industrial classifications. The results indicate that the profitability of midstream industries is lower than that of downstream food industries.

KEY WORDS
Food industry, B-to-B rate, operating income margin, smile curve.

DOI: 10.23762/FSO_VOL6_NO4_5

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Introduction

The food manufacturing industry is one of the largest manufacturing industries in Japan. This industry has the highest number of establishments and employees in Japan, as shown in the Census of Manufacture of the Ministry of Economy, Trade and Industry "Companies Statistics Guide" (Ministry of Economy, Trade and Industry 2014). However, the manufacturing value added by this industry is less than in other industries. In recent years, it has become difficult to maintain the food manufacturing industry owing to intense price competition. For this reason, it is extremely important to enhance added value and differentiate products. In particular, the food industry is facing intensive demand from the distribution industry. Furuzawa and Kiminami (2017) clarified the mechanism of change in the international division of labour based on an international input–output table. In addition, they suggested changes in the international division of labour relations in East Asia.

This study analysed the industrial organisation of the food industry by dividing the industry into upstream, midstream, and downstream categories. The upstream category mainly consists of materials; the midstream category is primarily composed of the food product industry; and the downstream category primarily comprises stores, retail, wholesale, and distribution. We used detailed industrial classifications

Paper received: 28 August 2018 • Paper revised: 27 October 2018 • Paper accepted: 25 November 2018

for the food manufacturing industry. First, we defined the Japanese food industry (categories of economic census in this paper, from "raw materials such as 011 tillage species agriculture," "76 restaurant," and up to "77 food take-out and delivery service industry") for each upstream, midstream, and downstream industry (Takahashi, 1989).

Subsequently, we analysed the business relationship between each industry and calculated a quantitative index referred to as the B-to-B rate. This is described in detail later.

Numerous studies have analysed the horizontal division of labour and focused on the "smile curve." For example, Kimura (2003; 2006) investigated the smile curve for the assembly manufacturing industry. However, quantitative research is required, and there are only a few studies on the smile curve for the food manufacturing industry. Therefore, this study quantitatively verified the smile curve for the food industry.

In addition, this paper introduces existing research, a method of conducting analysis, and the results of two kinds of analysis, a discussion, and a conclusion. The first analysis is a profitability analysis based on Japanese industry classification of upstream industry, midstream industry, and downstream industry; and the second analysis is a profitability analysis based on the original B-to-B rate, which is the novelty of our research.

1. Literature review

Hippel (1976; 1986; 1991) suggested that the sources of innovation are derived not only from manufacturing companies, which create products professionally, but also from users and suppliers. He concluded that the results of research, users, suppliers, and "other" are the main innovators. In addition, Ogawa (2000) investigated the innovation of Japanese retail companies. The Japanese convenience store "SEVEN ELEVEN" has been developing new items with food manufacturing industries. In addition, they are examining the background for product innovation in terms of using a store ordering system. "SEVEN ELEVEN" has developed distribution technology in collaboration with the NEC Corporation, and they request that food manufacturers propose new products. Kiminami and Kiminami (1998) examined the relationships between Japanese food manufacturing companies and overseas subsidiaries. These relationships have changed from the vertical division of labour to the horizontal division.

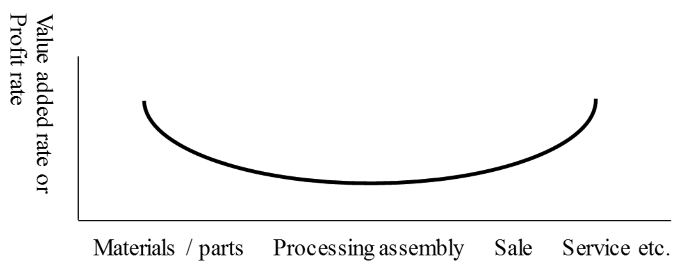
Productivity problems have been reported in the field of food production. Hironaka (2008) concluded that the food manufacturing industry is divided into a group with high productivity, which uses machinery with production management methods, and a group with low productivity, which utilises only manual production. He stated that the low productivity group must adopt production management methods for improvement. The Japanese food manufacturing industry is in the low productivity group because of relatively lower IT literacy and the fact that the organisation is old. Technical progress is insufficient for these reasons.

Throughout the food manufacturing and processed food industry, no correlation was observed between the operating margin and sales management expense rate. In the case of the material-type food industry with low selling and administrative expenses, any increase in these expenses will lead to an increase in operating profit. However, the processed food industry has high cost-of-sales and administrative expenses, and no correlation was observed between an increase in these expenses and a decrease in operating profit. It has been reported that an increase in selling and administrative expenses does not contribute to the improvement of profit (Hironaka, 2012).

On the contrary, in the food-related downstream industry, Hayashi (2012) reported that oligopolies are progressing, and the buying power of major retailers is increasing in the downstream retail and distribution industry. Changju (2011) suggested that the power balance between manufacturers and retailers in food-related industries has changed. Furthermore, we adopted the approach of industrial organisation theory and observed that the reversal of decision-makers from manufacturers to large-scale retailers has occurred. Sato (2013) confirmed the causes of the low profit margin of the food manufacturing industry to be logistics costs and procurement methods. Each department in the industry is closely related to a variety of customer requirements, and distribution costs have increased.

In the value chain, the midstream industry has low profitability and the upstream and downstream industries have high profitability. This is referred to as the "smile curve," a term which was advocated by Stan Shih, the founder and chairman of the Taiwanese computer manufacturer Acer Inc. For example, he examined the relationship between added value and the value chain for personal computers. In a smile curve, the order of distribution (upstream, midstream, downstream industry) is plotted on the horizontal axis and added value is plotted on the vertical axis. In this manner, a U-shaped curve that looks like a smiling face is obtained. Fig. 1 shows a conceptual diagram of the smile curve. As a result of the progress made in the standardisation and modularisation of core parts in the processing and assembly of products, the technical failures of products have declined and it has become easy for emerging companies to enter the market. The added value and profitability of the midstream industry has decreased.

Figure 1. Conceptual diagram of the smile curve



Source: Own elaboration based on Kimura, 2003.

In the PC industry, processing and assembling companies cannot generate sufficient revenue. Grove (1997) reported that Intel's strategies have changed, and its CPU business has spread in markets worldwide. In contrast, large computer manufacturers, which previously occupied a dominant position, now only purchase and assemble main parts and software. In addition, Aoki and Ando (2002) showed that IBM invented and modularised an open architecture computer to make various parts compatible. This resulted in considerable success. Eventually, several start-up companies specialising in specific components and software entered the market, and IBM's competitors could assemble PCs easily. Thus, IBM's PC market share decreased. Hyakushima (2007) analysed the supply chain of the Japanese automobile industry and electronics industry.

The upstream categories of materials and components provide high added value and are relatively facility-intensive. Specialised companies in different industries are actively developing food product manufacturing technologies, as described later. It appears that the horizontal division of labour is progressing. Even though the concept of the smile curve is widely known in general, there are extremely few studies pertaining to this. In overseas research on the smile curve, Low and Elms et al. (2013) analysed changes in the international value chain using WTO data from the 1970s to the 2010s. Baldwin et al. (2012; 2014; 2015) implemented the smile curve in the manufacturing industry in Asian countries. Additionally, David (2012) analysed the UK global value chains that actually add value. That work compares the value chains of the 1970s to those of the 21st century and finds that the central part of the smile curve has become deeper. The reasons for the change are rising relative market power and internationally mobile technology.

As the representative research on the smile curve in Japan, Shin et al. (2012) conducted the verification of the smile curve based on the ROA and ROE of 300 electric industry sectors from 2000 to 2005. Kimura (2003; 2006) analysed the curves of automobile industries using the total asset sales surplus rate. However, there are still only a few empirical studies on the smile curve, particularly for Japanese companies. Table 1 shows the main literature on the smile curve.

It should be noted that, in this study, the B-to-B rate is calculated using data from input-output tables.

Table 1. Main literature regarding the smile curve

Name of researcher	year	Target area	Applicable industries	Article title
Kimura, T.	2003	Japan	Processed assembly type manufacturing industry	Smile curve phenomenon in processed assembled manufacturing industry in Japan - verification and correspondence -
Kimura, T.	2006	Japan	Processed assembly type manufacturing industry	Reexamination of smile curve formation in processed assembled manufacturing industry in Japan
Hyakushima, T.	2007	Japan	Car industry, Electronics industry	Verification of smile curve phenomenon and international comparison of location competitiveness - micro analysis and policy implications on the supply chain of Japan's manufacturing industry
Fujimoto, Y.	2009	Japan	IT industry	Typology of division of labour in the IT industry
David, G.	2012	Global	Trade	The UK in a Global World: How can the UK focus on steps in global value chains that really add value?
Baldwin, Richard E.	2012	Asia	Trade	Global supply chains: Why they emerged, why they matter, and where they are going, Asian Perspectives Global Issues
Shin, N. Kraemer, Kenneth L. Dedrick, J.	2012	Global	Electronics industry	Value capture in the global electronics industry: Empirical evidence for the "smiling curve" concept
Elms, Deborah K. Low, P.	2013	Global	Trade	Global value chains in a changing world
Low, P.	2013	Global	Trade	The role of services in global value chains
Baldwin, Richard E. Ito, T. Sato, H.	2014	Asia	Trade	Portrait of Factory Asia: Production network in Asia and its implication for growth –the 'smile curve'
Baldwin, Richard E. Evenett, Simon J.	2015	Global	Trade	Value creation and trade in 21st century manufacturing

Source: Own elaboration.

This data has been practically used for a wide range of analysis in academic fields. For example, Kobayashi et al. (1982) analysed the energy dependence of the food industry using input–output tables. Nakajima (1994) stated that the input–output analysis is a useful method for analysing industrial structure. Organisation theory is an important approach for analysing the food industry. This study conducted a quantitative analysis of the operating income rate and B-to-B rate to verify the smile curve in the aggregate of food-related industries using data from input–output tables. The research question examined in this study is: "is the profitability of food manufacturing companies lower than upstream and downstream food industries in Japan's food manufacturing industry?" Moreover, we analyse this question with a novel approach using the B-to-B rate index.

2. Method of analysis

The study used "2012 Economic Census" and "Heisei 24 (2012) extended Input-Output Table (Ministry of Economy, Trade and Industry 2012; 2018)" for the analysis. First, we analyse the profitability of each upstream, midstream, and downstream industry involved in the value chain in the Japanese domestic food industry. Furthermore, we calculate the B-to-B rate, which quantifies the transaction relationships between industries, and validate it with the operating income margin on sales. The industries in the food manufacturing sector are classified into subdivisions such as "094 seasoning manufacturing industry." We calculate the profitability of each industry in these subdivisions. In this study, the rate of return is calculated using economic census data. This is because sufficient profitability data for downstream industries (e.g. wholesale) and upstream industries (e.g. agriculture and fishery) cannot be obtained from input–output tables or other basic statistics. Therefore, in this study, we verify the profitability of the entire value chain using sales and operating income figures in upstream industries such as agriculture and fishery as described in "Heisei 24 (2012) Economic Census." We define the industries from "011 hydroponic species agriculture" to "094 seasoning manufacturing industry" as upstream industries. The industries from "095 sugar manufacturing industry" to "26 production machine manufacturing industry" are included in midstream industries. Downstream industries include "521 wholesale of agricultural products and livestock products and marine products" and "77 take-out and delivery food services." Based on this classification, upstream industries include primary industries and raw materials, midstream industries include industries related to the processing and manufacturing of food products, and downstream industries include industries involved in the distribution of products, such as wholesale.

The classification based on statistics is qualitative, and this type of classification is also criticised because this method classifies industries into three categories. Therefore, in the following sections, the paper will present the categorisation of industries quantitatively by calculating the B-to-B rate and analysing the relationship between the rate and profitability. The calculation using this extended input-output table is summarised in Figure 2. It should be noted that the definition of "2012 Economic Census" is different from that of "Heisei 24(2012) extended Input-Output Table" of the industry. Initially, the authors matched the classification of industries. The correspondence relationship of industrial classification is shown in the Appendix. The B-to-B rate is calculated using the following equation:

(B-to-B rate calculation formula)

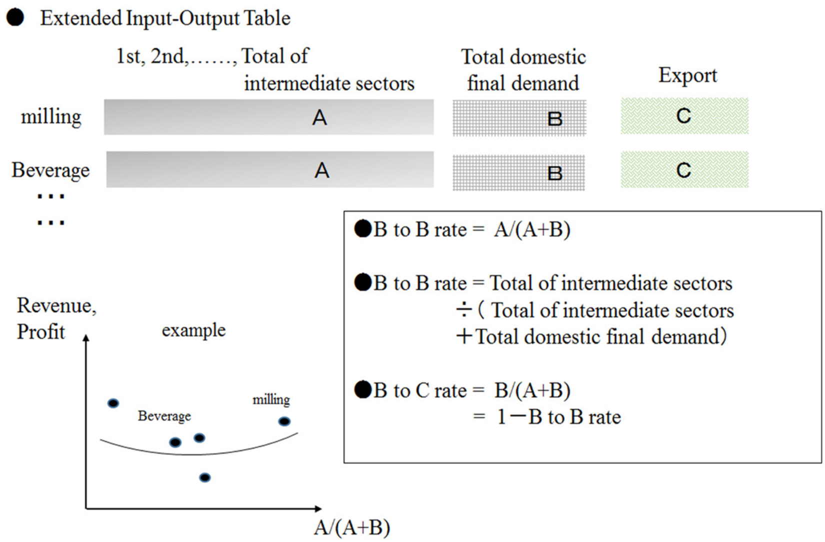
B-to-B rate = Total number of intermediate sectors / (Total number of intermediate sectors + Total domestic final demand)

Also, the definition of "average sales data" used in the analysis is as follows:

(Average sales data)

(Average sales data = Amount of sales / Number of companies

Figure 2.Calculation ofthe B-to-B rate from the extended input-output table



Source: Own elaboration.

When calculating the B-to-B rate in this study, the total of the intermediate sectors was assumed to be a B-to-B transaction, and the total domestic final demand was assumed to be a B-to-C transaction. Export and import products were excluded from the scope of this study because they cannot be classified. However, it is a meaningful step to quantitatively grasp the transactions and final consumers in the industry using the ratio of demand to the food-related industry in Japan. We plotted a graph using this B-to-B rate and the operating income margin to verify the smile curve. Subsequently, a regression analysis was conducted using the profitability rate as an independent variable and the squared value of the B-to-B rate and the B-to-B rate as dependent variables.

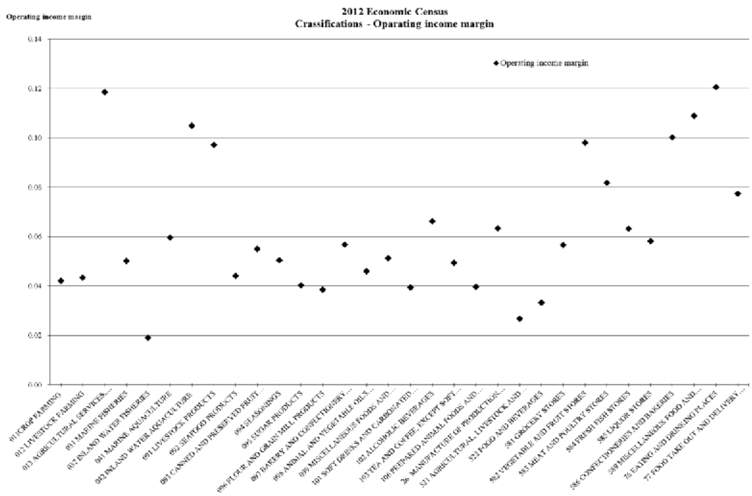
3. Results of analysis

3.1. Profitability analysis of upstream, midstream, and downstream industries

The operating income margin was calculated for each classification item. In Figure 3, the horizontal axis of the graph shows the classification items arranged category-wise in numerical order, and the vertical axis of the graph shows the operating profit ratio. At first glance, the operating profit margins of the industries located on the left and right sides of the figure are relatively higher than that of industries located at the centre of the figure. Table 2 lists the categorisation results of upstream, midstream, and downstream industries. A graph of the average value of each stream is shown in Figure 4, illustrating the aspects of the smile curve.

As a result, the average values of the operating income margin of upstream, midstream, and downstream industries are 0.062, 0.049, and 0.075, respectively. The operating income of midstream industries is lower than those of upstream and downstream food industries. The most profitable industry among the upstream industries is "013 agricultural service industry".

Figure 3. Relationship between classification items and operating income margin



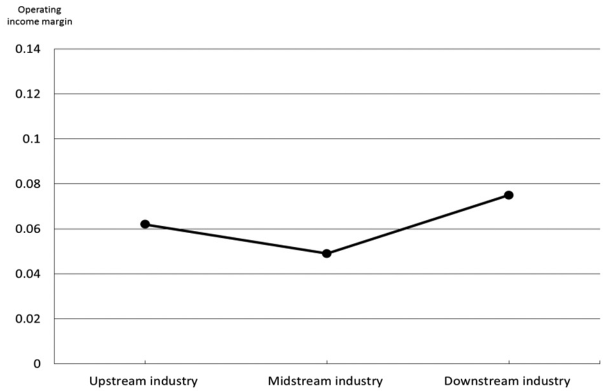
Source: Own elaboration.

Table 2. Upstream, midstream, and downstream industries and operating income margin by item

Upstream industry (raw material related industry)		Midstream industry (Food manufacturing and processing industry)		Downstream industry (distribution industry, restaurant)	
Japan Standard Industrial Classification	Operating income margin	Japan Standard Industrial Classification	Operating income margin	Japan Standard Industrial Classification	Operating income margin
011CROP FARMING	0.042	095 SUGAR PRODUCTS	0.040	521 AGRICULTURAL, LIVESTOCK AND AQUATIC PRODUCTS	0.027
012 LIVESTOCK FARMING	0.043	096 FLOUR AND GRAIN MILL PRODUCTS	0.039	522 FOOD AND BEVERAGES	0.033
013 AGRICULTURAL SERVICES, EXCEPT GARDANING SERVICES	0.119	097 BAKERY AND CONFECTIONERY PRODUCTS	0.057	581 GROCERY STORES	0.057
031 MARINE FISHERIES	0.050	098 ANIMAL AND VEGETABLE OILS AND FATS	0.046	582 VEGETABLE AND FRUIT STORES	0.098
032 INLAND WATER FISHERIES	0.019	099 MISCELLANEOUS FOODS AND RELATED PRODUCTS	0.051	583 MEAT AND POULTRY STORES	0.082
041 MARINE AQUACULTURE	0.060	101 SOFT DRINKS AND CARBONATED WATER	0.039	584 FRESH FISH STORES	0.063
042 INLAND WATER AQUACULTURE	0.105	102 ALCOHOLIC BEVERAGES	0.066	585 LIQUOR STORES	0.058
091 LIVESTOCK PRODUCTS	0.097	103 TEA AND COFFEE, EXCEPT SOFT DRINKS AND CARBONATED WATER	0.049	586 CONFECTIONERIES AND BAKERIES	0.100
092 SEAFOOD PRODUCTS	0.044	106 PREPARED ANIMAL FOODS AND ORGANIC FERTILIZERS	0.040	589 MISCELLANEOUS FOOD AND BEVERAGE STORES	0.109
093 CANNED AND PRESERVED FRUIT AND VEGETABLE PRODUCTS	0.055	26 MANUFACTURE OF PRODUCTION MACHINERY	0.063	76 EATING AND DRINKING PLACES	0.121
094 SEASONINGS	0.050			77 FOOD TAKE OUT AND DELIVERY SERVICES	0.077
Average of Upstream industry	0.062	Average of Midstream industry	0.049	Average of Downstream industry	0.075

Source: Own elaboration.

Figure 4. Relationship between each stream of industry and operating income margin



Source: Own elaboration.

It includes nursery centres, rice centres, the agricultural facility maintenance industry, land improvement districts, the vegetables co-selection field, and the artificial insemination industry. In addition, the most profitable downstream industry is "76 restaurant" which includes cafeterias and restaurants. On the contrary, midstream industries have relatively low profitability. The most profitable midstream industries are "096 milling industry" and "101 soft drink manufacturing industry" and include companies that manufacture soft drinks but do not include the wheat flour manufacturing and alcohol industries.

3.2. Profitability analysis using the B-to-B rate

This study calculated the B-to-B rate by using the input-output table. Table 3 lists the results of the calculation. Figure 5 shows the B-to-B rate on the horizontal axis and its profitability on the vertical axis. Industries located on the left and right sides of the figure show relatively high profitability compared to those located at the centre. To demonstrate this quantitatively, a multiple regression analysis was performed for 32 industries.

However, the phenomenon of the smile curve was not clear from the analysis. Therefore, in terms of the seven categories of agriculture (011, 012, 013) and fishery (031, 032, 041, 042) in upstream industry, it is not a usual business entity owing to special circumstances in Japan. Therefore, we decided to calculate these figures without it. Additionally, multi-variable regression analysis was performed by adding several explanatory variables. These included only the squared value of the B-to-B rate and the B-to-B rate itself, but also the number of companies in each industry and the average value of sales.

We conducted a multi-variable regression analysis by using the operating income margin as the independent variable and the squared value of the B-to-B rate and the B-to-B rate itself as dependent variables along with the number of companies in each industry and the average value of sales. As a result, the squared value of the B-to-B rate was not significant. The B-to-B rate was 1% significantly negative. Table 3 lists the results of the multi-variable regression analysis and Figure 5 shows the line obtained using the regression formula. With these results, regarding agriculture and fisheries in upstream industry, we decided to exclude this point of analysis as conventional individual management constitutes the majority of cases. From these results, the line obtained is similar to the smile curve presented in previous research and which has also been obtained in the food industry. The result is consistent with the notion that the higher the B-to-C rate, the higher the operating income margin.

Table 3. Upstream, midstream, and downstream industries with their B-to-B rate and operating income margin by item

Upstream industry (raw material related industry)			Midstream industry (Food manufacturing and processing industry)			Downstream industry (distribution industry, restaurant)		
Japan Standard Industrial Classification	B to B rate	Operating income margin	Japan Standard Industrial Classification	B to B rate	Operating income margin	Japan Standard Industrial Classification	B to B rate	Operating income margin
011CROP FARMING	0.66	0.042	095 SUGAR PRODUCTS	0.96	0.040	521 AGRICULTURAL, LIVESTOCK AND AQUATIC PRODUCTS	0.61	0.027
012 LIVESTOCK FARMING	0.90	0.043	096 FLOUR AND GRAIN MILL PRODUCTS	0.50	0.039	522 FOOD AND BEVERAGES	0.61	0.033
013 AGRICULTURAL SERVICES, EXCEPT GARDANING SERVICES	1.00	0.119	097 BAKERY AND CONFECTIONERY PRODUCTS	0.10	0.057	581 GROCERY STORES	0.13	0.057
031 MARINE FISHERIES	0.90	0.050	098 ANIMAL AND VEGETABLE OILS AND FATS	0.86	0.046	582 VEGETABLE AND FRUIT STORES	0.13	0.098
032 INLAND WATER FISHERIES	0.82	0.019	099 MISCELLANEOUS FOODS AND RELATED PRODUCTS	0.30	0.051	583 MEAT AND POULTRY STORES	0.13	0.082
041 MARINE AQUACULTURE	0.57	0.060	101 SOFT DRINKS AND CARBONATED WATER	0.13	0.039	584 FRESH FISH STORES	0.13	0.063
042 INLAND WATER AQUACULTURE	0.82	0.105	102 ALCOHOLIC BEVERAGES	0.45	0.066	585 LIQUOR STORES	0.13	0.058
091 LIVESTOCK PRODUCTS	0.46	0.097	103 TEA AND COFFEE, EXCEPT SOFT DRINKS AND CARBONATED WATER	0.53	0.049	586 CONFECTIONERIES AND BAKERIES	0.13	0.100
092 SEAFOOD PRODUCTS	0.30	0.044	106 PREPARED ANIMAL FOODS AND ORGANIC FERTILIZERS	0.85	0.040	589 MISCELLANEOUS FOOD AND BEVERAGE STORES	0.13	0.109
093 CANNED AND PRESERVED FRUIT AND VEGETABLE PRODUCTS	0.37	0.055	26 MANUFACTURE OF PRODUCTION MACHINERY	0.19	0.063	76 EATING AND DRINKING PLACES	0.03	0.121
094 SEASONINGS	0.42	0.050				77 FOOD TAKE OUT AND DELIVERY SERVICES	0.03	0.077
Average of Upstream industry	0.66	0.06	Average of Midstream industry	0.49	0.05	Average of Downstream industry	0.20	0.07

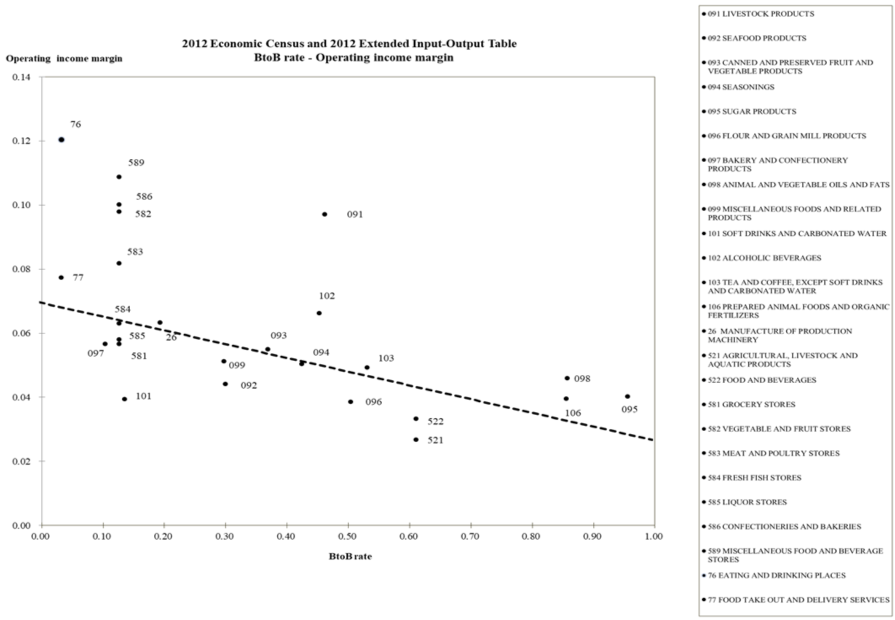
Source: Own elaboration.

4. Discussion

In this research, we calculated the operating income margin of subdivision industries in the food manufacturing sector using the input-output table. This revealed profitability in upstream, midstream, and downstream food industries. The operating income margins of sales in the upstream and downstream industries are higher than that of midstream industries.

In addition, the study analysed the B-to-B rate of each subdivision industry. A low or high B-to-B rate indicates a relatively high profit. Subsequently, a regression analysis was conducted by using the operating income margin as the independent variable and the squared value of the B-to-B rate and the B-to-B rate as dependent variables. The results showed that the coefficient of the B-to-B rate was significantly negative, and the coefficient of the squared value of the B-to-B rate was significantly positive. These could demonstrate the shape of an exact smile curve. Hironaka (2012), Hayashi (2012), and Sato (2013) also pointed out the low profitability of midstream industries in previous studies. They mentioned that the operating income margin is low because sales and administrative expenses and logistics costs are high.

Figure 5. Relationship between classification items and operating income margin



Source: Own elaboration.

Table 4. Results of regression analysis (excluding agriculture and fisheries)

n	25	
Correction R2	0.441127345	
	Coefficient	
Intercept	0.072275523	**
BtoB rate	-0.044725135	*
Number of companies	1.49E-07	*
Average sales data	1.19E-06	

Note: $^*p < 0.05$, $^{**}p < 0.01$

Source: Own elaboration.

Several existing studies have attempted to demonstrate the smile curve. However, there are few quantitative analyses that classify upstream, midstream, and downstream industries. For example, Hyakushima (2007) verified the smile curve in the European automotive industry. However, the industries were categorised through considering the main operation qualitatively. In this study, industries were classified quantitatively based on the B-to-B rate by using the extended input-output table. There is no need to quantitatively consider business activities for each company.

The industry with the highest B-to-B rate is "013 agricultural service industry" – nursery centres and rice centres, agricultural facility maintenance and management, land improvement districts, cooperative vegetable selection sites, and the artificial insemination industry. The operating income margin is second-highest for the category "013 agricultural service industry" among the 32 industrial categories of the food industry. The industries with the lowest B-to-B rate are "76 restaurant," and "77 take-out and delivery beverage services industry," which include cafeterias, restaurants, and service industries that provide food and drink, such as hamburger outlets, take-away lunch vendors, and pizza delivery.

Industries had the lowest profitability when the B-to-B rate was approximately 0.5. These are "521 agricultural and livestock products and marine product wholesale business," "522 food and beverage wholesale business," and "032 inside water fishery." Specifically, it covers the wholesale of rice, vegetables, meat, fresh fish, sugar, sake, dry matter, river fishery, and lake fishery. These wholesale businesses were mainly opened in shopping districts. This has overlapped with recent market conditions such as the closure of shopping districts and an increase in the number of shutter shopping districts (Nakano, 2012).

It is interesting to note the difference in the profitability of the "information service industry," which is a downstream electrical industry. Fujimoto (2009) stated that the information service industries within the IT industry are organised by the division of labour of software companies. The industry shows a subcontracted structure, and profitability is very low. Kobayashi (2004) also pointed out that in information service industries, the prime contractors lead the hierarchy of the subcontracted structure. It must be noted that the agricultural service industry is not structured around subcontracting. Furthermore, the agricultural service industry offers high value-added services that only target farmers. Kimura (2003; 2006) pointed out that advancing to the upstream and downstream of the value chain is essential for companies when the smile curve is observed. Considering this fact, the profit margin is low for the food industry considered in this research, owing to intense competition in the food products processing and manufacturing industries. Several companies can improve their profit margins by advancing to upstream industries such as those dealing in raw materials and seasonings. For example, Imuraya Group Co., Ltd., a grocery manufacturing company, has been focusing on manufacturing sweets by using red bean curd refuse. They developed a food material that is the core of the B-to-B business and strengthened product development capabilities (Imuraya, 2018). Tsuji Seiyu Oil Refining Co., Ltd. of Mie Prefecture is an edible oil manufacturing company. With the cooperation of Kochi Prefecture JA Aki Tosa, the company created and sold natural flavours of citrus oil to leverage the company's extraction technology (Tsuji Seiyu, 2018).

Conclusions

In this research, we compared the profitability of upstream, midstream, and downstream industrial categories. The results showed that, even in the food industry, compared with the profitability of upstream and downstream industries, the profitability of midstream industries was relatively low. Furthermore, to quantitatively classify upstream, midstream, and downstream industries, the B-to-B rate was analysed. Thus, by quantitatively analysing the relationship between the industrial organisation and profitability of the food industry in Japan, we verified the smile curve.

There are few existing studies on smile curves – although there are some qualitative studies, there are few quantitative empirical studies. In the field of curves and profitability, there are many studies centred on process assembly-type manufacturing industry. Hence, this study on food industries is something of a rarity and a clear novelty in academic terms. In addition, this paper presented an analytical method using a unique index called B-to-B rate, which is thought to constitute a new academic contribution. Therefore, the novelty herein lies in analysing profitability using new indicators for the food industry contributing to management science in this way.

On the other hand, this study uses only data from a single year, namely 2012. Therefore, if the data from other years is applied, the value of profitability in each industry may change significantly. However, the statistical data used herein has been compiled from 2012. Therefore, we cannot know past figures and we cannot confirm changes from the past, which constitutes a limitation of this study. Finally, the Japanese Economic Census will be implemented and conducted every four years. In the future, each time the results of the Economic Census are announced, we will continue to accumulate and analyse the data.

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Appendix 1.
Correspondence of classification items "2012 Economic Census" and "2012 Extended Input-Output Table"

2012 Extended Input-Output Table industry classification	2012 Economic Census Industry small classification	2012 Extended Input-Output Table industry classification	2012 Economic Census Industry small classification	2012 Extended Input-Output Table industry classification	2012 Economic Census Industry small classification	2012 Extended Input-Output Table industry classification	2012 Economic Census Industry small classification
Rice	011 CROP FARMING	Raw milk	012 LIVESTOCK FARMING	Beef	091 LIVESTOCK PRODUCTS	Animal oils and fats	098 ANIMAL AND VEGETABLE OILS AND FATS
Rice straw	011 CROP FARMING	Miscellaneous dairy farming products	012 LIVESTOCK FARMING	Pork	091 LIVESTOCK PRODUCTS	Cooking oil	098 ANIMAL AND VEGETABLE OILS AND FATS
Wheat (domestic)	011 CROP FARMING	Beef cattle	012 LIVESTOCK FARMING	Chicken meat	091 LIVESTOCK PRODUCTS	Vegetable meal	098 ANIMAL AND VEGETABLE OILS AND FATS
Wheat (imported)	—	Hogs	012 LIVESTOCK FARMING	Miscellaneous meat	091 LIVESTOCK PRODUCTS	Condiments and seasonings	094 SEASONINGS
Barley (domestic)	011 CROP FARMING	Hen eggs	012 LIVESTOCK FARMING	By-products of slaughtering and meat processing	091 LIVESTOCK PRODUCTS	Prepared frozen foods	099 MISCELLANEOUS FOODS AND RELATED PRODUCTS
Barley (imported)	—	Chickens	012 LIVESTOCK FARMING	Processed meat products	091 LIVESTOCK PRODUCTS	Retort foods	099 MISCELLANEOUS FOODS AND RELATED PRODUCTS
Sweet potatoes	011 CROP FARMING	Sheep and hemp wool	012 LIVESTOCK FARMING	Bottled or canned meat products	091 LIVESTOCK PRODUCTS	Dishes, sushi and lunch boxes	099 MISCELLANEOUS FOODS AND RELATED PRODUCTS
Potatoes	011 CROP FARMING	Livestock, n.e.c.	012 LIVESTOCK FARMING	Drinking milk	091 LIVESTOCK PRODUCTS	School lunch (public) **	099 MISCELLANEOUS FOODS AND RELATED PRODUCTS
Soybeans (domestic)	011 CROP FARMING	Veterinary service		Dairy products	091 LIVESTOCK PRODUCTS	School lunch (private) *	099 MISCELLANEOUS FOODS AND RELATED PRODUCTS
Soybeans (imported)		Agricultural services (except veterinary service)	013 AGRICULTURAL SERVICES, EXCEPT GARDENING SERVICES	Frozen fish and shellfish	092 SEAFOOD PRODUCTS	Miscellaneous foods	099 MISCELLANEOUS FOODS AND RELATED PRODUCTS
Miscellaneous pulses	011 CROP FARMING	Silviculture	—	Salted, dried or smoked seafood	092 SEAFOOD PRODUCTS	Refined sake	102 ALCOHOLIC BEVERAGES
Vegetables	011 CROP FARMING	Logs (domestic)	—	Bottled or canned seafood	092 SEAFOOD PRODUCTS	Malt liquors	102 ALCOHOLIC BEVERAGES
Citrus fruits	011 CROP FARMING	Logs (imported)	—	Fish paste	092 SEAFOOD PRODUCTS	Whiskey and brandy	102 ALCOHOLIC BEVERAGES
Apples	011 CROP FARMING	Special forest products (including hunting)		Miscellaneous processed seafood	092 SEAFOOD PRODUCTS	Miscellaneous liquors	102 ALCOHOLIC BEVERAGES
Miscellaneous fruits	011 CROP FARMING	Marine fishery (domestic)	031 MARINE FISHERIES	Milled rice	096 FLOUR AND GRAIN MILL PRODUCTS	Tea and roasted coffee	103 TEA AND COFFEE, EXCEPT SOFT DRINKS AND CARBONATED WATER
Sugar crops	011 CROP FARMING	Marine fishery (imported)		Miscellaneous grain milled	096 FLOUR AND GRAIN MILL PRODUCTS	Soft drinks	101 SOFT DRINKS AND CARBONATED WATER
Green coffee and cocoa beans (imported)	—	Marine aquaculture	041 MARINE AQUACULTURE	Wheat flour	096 FLOUR AND GRAIN MILL PRODUCTS	Manufactured ice	—
Miscellaneous crops for beverages	011 CROP FARMING	Inland water fishery and inland water aquaculture	032 INLAND WATER FISHERIES, 042 INLAND WATER AQUACULTURE	Miscellaneous grain milled products	096 FLOUR AND GRAIN MILL PRODUCTS	Feeds	106 PREPARED ANIMAL FOODS AND ORGANIC FERTILIZERS
Miscellaneous cereals	011 CROP FARMING	Iron ores	—	Noodles	099 MISCELLANEOUS FOODS AND RELATED PRODUCTS	Organic fertilizers, n.e.c.	106 PREPARED ANIMAL FOODS AND ORGANIC FERTILIZERS
Oil seeds	011 CROP FARMING	Non-ferrous metallic ores		Bread	097 BAKERY AND CONFECTIONERY PRODUCTS	Tobacco	
Edible crops, n.e.c.	011 CROP FARMING	Coal mining	—	Confectionery	097 BAKERY AND CONFECTIONERY PRODUCTS	Food processing machinery and equipment	26 MANUFACTURE OF PRODUCTION MACHINERY
Feed and forage crops	011 CROP FARMING	Crude petroleum	—	Bottled or canned vegetables and fruits	093 CANNED AND PRESERVED FRUIT AND VEGETABLE PRODUCTS	Wholesale trade	521 AGRICULTURAL, LIVESTOCK AND AQUATIC PRODUCTS, 522 FOOD AND BEVERAGES
Seeds and seedlings	011 CROP FARMING	Natural gas	—	Preserved agricultural foodstuffs (except bottled or canned)	093 CANNED AND PRESERVED FRUIT AND VEGETABLE PRODUCTS		
Flowers and plants	—	Gravel and quarrying	—	Refined sugar	095 SUGAR PRODUCTS	Retail trade	581 GROCERY STORES, 582 VEGETABLE AND FRUIT STORES, 583 MEAT AND POULTRY STORES, 584 FRESH FISH STORES, 585 LIQUOR STORES, 586 CONFECTIONERIES AND BAKERIES, 589 MISCELLANEOUS FOOD AND BEVERAGE STORES
Leaf tobacco		Crushed stones		Miscellaneous sugar and by-products of sugar manufacturing	095 SUGAR PRODUCTS		
Raw rubber (imported)		Limestone		Starch	095 SUGAR PRODUCTS		
Raw cotton (imported)		Materials for ceramics (except limestone)		Dextrose, syrup and isomerized sugar	095 SUGAR PRODUCTS	Miscellaneous business services	76 EATING AND DRINKING PLACES, 77 FOOD TAKE OUT AND DELIVERY SERVICES
Inedible crops, n.e.c.		Clay, n.e.c.		Vegetable oil	098 ANIMAL AND VEGETABLE OILS AND FATS		