Economic Ripple Effects of Health-Functional Food Industry Applying Input-Output Analysis*

Donghoon Kim** Inbae Ji***

Keywords

Health-Functional Food, Input-Output Analysis, Economic Analysis, Economic Ripple Effect

Abstract

This study measures the ripple effect of the fast-growing health-functional food industry on the national economy, based on input-output analysis. An endogenous household consumption model is adopted to measure the economic ripple effect, which can measure both direct and indirect effects and inducement effects. The results show that the health-functional food industry mostly procures intermediate goods produced domestically, and also has excellent job creation effects. Also, the health-functional food industry growth contributes to higher economic ripple effects on national industrial development due to high backward linkage effects. However, many small-scale enterprises in the industry show structural weakness.

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** Ph.D Student, Department of Food Industry Management, Dongguk University.

*** Assistant professor, Department of Food Industry Management, Dongguk University, corresponding author.
e-mail: jiinbae@dongguk.edu

1. Introduction

In the food industry of Korea, the conditions of food consumption are changing fast thanks to more and more income, the increasing number of one-person households, people's desire for healthy living, and the increasing elderly population[1] . Also, as food technologies develop and diversified foods are available, the health-functional food market emphasizing the functionalities of raw materials is growing fast. In 2017, the scale of the Korean health-functional food market was 2 trillion 704.7 billion won[2] and showed a 10.8% of increase per annum on the average for the latest five years. Total marketing volume is 2 trillion 237.4 billion won, accounting for 0.13% compared to GDP (Gross Domestic Products), 0.47% compared to GDP of the manufacturing industry, and 2.45% compared to the food industry. Moreover, in 2017, the amount of exported and imported health-functional food was 107.7 and 575.4 billion won, respectively, showing 13.0% and 10.3% of annual increase on the average, respectively, after 2012 (Ministry of Food and Drug Safety, 2018). As described above, because it is expected that the health-functional food industry will continue to grow, it is thus necessary to conduct an accurate evaluation of its role and values from the perspective of national economic growth.

A health-functional food refers to the 'food manufactured (or processed) by using raw materials or components with functionalities[3] beneficial for human bodies' provided in the 'Health-functional Foods Act (HFA),' and is different from medicines, functional foods or ordinary foods. While the direct effect of health-functional food on healthier living and prevention of diseases, unlike ordinary foods, is further recognized, it is thus necessary to

1 The Population Projections by Statistics Korea reveals that the 65 or older population of Korea accounts for 14.3% as of 2018, and will increase fast to account for more than 20% in 2025, 30% in 2036 and 40% in 2051.

2 This is the number calculated by adding the volume of marketing in Korea and import in 2017.

3 A functionality means the beneficial effect for healthy living, for example, controlling nutrients for human body structure and functions, or physiological actions provided in the 'Health-functional Foods Act (HFA)'.

demonstrate the safety and functionalities thereof scientifically and differences in its operation and management system (Park et al., 2016). As a result, the HFA was enacted in August 2002, and has been enforced from January 2004 to establish a policy basis for ensuring the safety and functionalities of health-functional foods.

As such, although the health-functional food industry continues to grow, it is hard to find previous studies about the ripple effect of the health-functional food industry on the Korean economy. In general, each industry as a component of the national economy purchases intermediate materials, including raw materials and components from other industries, and combines them with the original production elements including labor and capital. Through the process, new goods or services are produced to sell them to other industries as an intermediate material or to end consumers to form an interdependency relation (Lim 2015). Therefore, it is necessary to examine interdependency between the health-functional food industry and the backward and forward linkage industries and analyze the economic ripple effect on individual industries and the entire economy to find out the feature of industrial development and suggest the direction of development.

Meanwhile, while most studies based on input-output analysis consider only the direct and indirect effects of the industry, this study includes the inducement effect by increased income in the ripple effect of the industry to avoid underestimating the substantial ripple effect. In particular, because the health-functional food industry is an industry with fast-growing consumption thanks to increased income, it is thus necessary to include the inducement effect by increased income in the economic ripple effect. In the US with the developed health-functional food industry, the economic ripple effect thereof is divided into the direct effect, indirect effect and inducement effect to measure them (Davanzo et al. 2009).[4]

Therefore, this study aims to derive the industrial input coefficient, the multiplier, and the

4 The US CRN (Council for Responsible Nutrition) shows that the dietary supplement industry contributes $121.6 billion to the U.S. economy (about 0.68% of GDP), creates 754,645 jobs nationwide, and pays $38.4 billion in wages. Additionally, the industry contributes nearly $15 billion in business taxes (federal and state) not including taxes collected on product sales (CRN 2016).

forward-backward linkage coefficients of related industries by applying input-output analysis to measure the economic effect of individual industries and between industries. The derived coefficients are applied to the sales performance data of health-functional foods to divide the economic ripple effect of the health-functional foods into direct effects, indirect production effects, and inducement effects to measure them. This study additionally analyzes the economic ripple effect of the health-functional food industry in each stage of raw materials, production, sale, and consumption to suggest implications for industrial development and related policies.

So far, most studies about health-functional foods have focused mainly on consumer's recognition of the health-functional foods (Shin 2006; Cha and Kim 2008; Kim and Joo 2010; Seol, Park, and Woo 2014; Kim 2018; Jeong, and Kim 2018; Park, Gong and Lee 2019). Other studies include the study on vitalizing the health-functional food market (Kim 2011; Kim 2013; Yoo 2015), the study on developing and certifying functional raw materials (Lee 2010; Lee 2013; Ha 2013; Seo 2015), and the study on advertising and labeling health-functional foods (Heo 2007; Jo 2009; Kim 2018).

Although there are many studies done for analyzing the economic ripple effect of individual industries by applying input-output analysis, only one study has been done on the economic ripple effect of the health-functional food industry by Lee et al. (2013). The 'Industrial Input-output Table in 2009' cited in the study by Lee et al. (2013) does not divide and suggest the 'health-functional food' separately, implying that the accurate economic effect is not possibly estimated.[5] Lee (2012), Park (2016), and Song (2018) used the endogenous household consumption model to solve the disconnection problem with exogenous variables by using the input-output model. Their studies are related to the medical and welfare industry, the tourism industry and the construction industry, and input-output analysis is not used much in other fields for using the endogenous household consumption model.

5 While the industry related to health-functional foods is not under an independent category in the Input-Output Tables before 2010, it belongs to the category of 'food and beverage'; to the division of 'food'; to the section of 'other food'; and to the primary category of 'ginseng and dietary supplements.'

Therefore, this study uses the '2010 Input-Output Table' and the '2015 Input-Output Table' in which 'ginseng and supplementary foods' belong to a different category to measure more accurate economic ripple effects of the health-functional food industry. Furthermore, an endogenous model for income and household consumption is applied to reflect the features of the health-functional food industry with great income effects to reflect the increased income effect to implement accurate ripple effect analysis of the health-functional food industry on the entire national economy.

2. Data

The 2010 and 2015 Input-Output Tables announced by the Bank of Korea were used to measure the economic ripple effect of the health-functional food industry by employing input-output analysis. While various types of the Input-Output Table are used depending on price evaluation, imports and edition formats, this study uses the input-output table of noncompetitive import type, which can measure more accurate economic ripple effects and is considered as a basic price useful for endogenous import.[6]

In this study, the scope of the health-functional food industry is established as "ginseng and dietary supplements" in the basic-classification of the input-output table.[7] However, it is

6 The Input-Output Table is classified into the competitive import type and the non-competitive import type depending on the method of handling imported products. The Input-Output Table of non-competitive import type putting Korean materials and imported materials in the category of intermediate input and final demand is based on the more realistic assumption that the Korean materials and imported materials are heterogeneous each other, and their input ratios are different in each industry. Meanwhile, although endogeneity of the import sector is allowed through the Input-Output Table of competitive import type, it is not completely ideal for classifying the pure effect by Korean production and imports.

7 Specific products belonging to "Ginseng and dietary supplements" can be referred to through the supply table published as annexed to the industry association table in 2010 and 2015. Direct comparison between "health-functional food industry" and "ginseng and dietary supplement foods" is difficult because it is not clearly presented in HFA. The domestic production value of "health functional foods" announced by the Ministry of Food and Drug Safety is 1.7326 trillion won while the domestic production value of "ginseng and dietary supplements" is 2.8839 trillion won in 2015. Therefore, production value of "ginseng and dietary supplements" is about 1.7 times larger than that of "health functional foods"

impossible to use the employment table of basic-classification because the basic-classification table does not provide labor-related information of “Ginseng and health supplements.” In contrast, the sub-classification table provides those of “other foodstuffs.” Therefore, labor-related information of “other foodstuffs” in the basic-classification from the employment table was collected based on the Economic Survey of the National Statistical Office (2010, 2015) and estimated the number of employment and job creation for “Ginseng and dietary supplements.”

To this end, for the primary industrial sector, the agricultural, forestry and fishery product category integrates agricultural, fishery and forestry products providing raw materials to health-functional foods, and mineral products with a different production process or sales structure are under a different category. In the manufacturing industry, health-functional foods to be analyzed are under a separate part in the primary category, and the food and beverage category with similar industrial features in the production or sale process is under the related industry category. Products related to the light industry and the heavy and chemical industry are integrated with the non-beverage and food products. For the service sector, the wholesale and retail business and the transportation industry transporting and selling health-functional foods are under a separate category. Restaurants and healthcare services are under a separate category, and other services are integrated under the other service category. For other category references, because electric power, water supply, and construction are a kind of social overhead capital providing infrastructure of individual industries, it is under the category of SOC (Social Overhead Capital).

Table 1. Classification of input-output table focusing on health-functional food industry

Sector	Basic category codes of input-output table	
	2010	2015 (serial No.)
Agricultural, forestry and fishery products	001~025	0111~0500 (001~025)
Mineral products	026~034	0611~0729 (026~034)
Food and beverages	035~052, 054~061	0811~1000 (035~051, 053~060)
Health-functional food	053	0873 (052)

(Continued)

Sector	Basic category codes of input-output table	
	2010	2015 (serial No.)
Non-food and beverages	062 ~ 273	1111 ~ 4402 (061 ~ 268)
SOC	274 ~ 301	4501 ~ 5190 (269 ~ 296)
Wholesale and retail	302 ~ 303	5200 (297)
Transportation industry	304 ~ 317	5310 ~ 5690 (298 ~ 309)
Restaurants	318 ~ 321	5811 ~ 5814 (312 ~ 315)
Health and welfare	365 ~ 370	7701 ~ 7802 (362 ~ 366)
Other services	322 ~ 364, 371 ~ 384	5710 ~ 7520, 5820 ~ 7603, 7901 ~ 8300 (310 ~ 311, 316 ~ 361, 367 ~ 381)

Source: 2010 Input-Output Table, 2015 Input-Output Table, Bank of Korea.

3. Method of Analysis

For this study, an input-output model was established for an economic impact analysis including production and job creation by deriving various coefficients, for example, input coefficients, value-added coefficients, and labor coefficients and then analyze the ripple effect of the health-functional food industry on the entire national economy. This study uses an extension model ,which is an endogenous form of income and household consumption based on the demand model widely used as a standard model for the economic ripple effect by following Song (2018).[8] Because changes in domestic production following changes of the final demand inevitably result in changing intermediate material income, it is necessary to make the income endogenous to consider those changes. Moreover, because changes of domestic production result in changing labor and capital changes, and changes of labor input mainly result in changes of household income to have an impact on household consumption, subsequently

8 The input-output model is classified into the demand model extraneously determining the final demand sector and the supply model extraneously determining the added value sector, and can be extended to include a mixed model making some of the final demand, import or added value sector endogenous, or some of the endogenous sector extraneous to analyze for particular purposes.

causing changes of final demand, another factor to be considered is the multiplier effect of income and consumption (Lee 2012; Park 2016; Song 2018).

Because it is difficult to measure the economic ripple effect by using the input coefficient where there are many industrial sectors, the inverse matrix is used to produce multipliers. the inverse matrixes $(I-A^{d})^{-1}$ and $(I-A^{d}-A^{cd}A^{y})^{-1}$ included in each balancing equation are called a Leontief's inverse matrix in the model of endogenous import and household consumption. Applying the import, added value, and labor-related coefficients defined in each model to the aforementioned output multiplier matrix allows each multiplier matrix to be produced from each model.

Table 3. Result of produced multiplier matrix for each analysis model

Multiplier	Endogenous import model	Endogenous import and household consumption model
Output	$(I-A^{d})^{-1}$	$(I-A^{d}-A^{cd}A^{y})^{-1}$
Import	$A^{m}(I-A^{d})^{-1}$	$(A^{m}+A^{cm}A^{y})(I-A^{d}-A^{cd}A^{y})^{-1}$
Added value	$A^{v}(I-A^{d})^{-1}$	$A^{v}(I-A^{d}-A^{cd}A^{y})^{-1}$
Labor	$A^{l}(I-A^{d})^{-1}$	$A^{l}(I-A^{d}-A^{cd}A^{y})^{-1}$

Note: A^{v} and A^{l} are a diagonal matrix having diagonal elements of value added coefficient a_j^{v} and labor coefficient a_j^{l}, respectively.

4. Result of Analysis

4.1. Calculated Input Coefficient

The intermediate input coefficients calculated by using the Input-Output Table in 2010 and 2015 were 74.8% and 74.4%, respectively, implying stability for five years. While this is similar to the average of the manufacturing industry (78.2%, 73.9%), but greater than the average of the service industry (44.6%, 44.4%), it is smaller than the average of food and beverage products (84.2%, 82.9%) which is similar to it. While the imported material input coefficient increased from 2.5% to 3.7% in intermediate input, it is even smaller than food and beverage products (14.7%, 14.0%) or non-food and beverage products (23.9%, 21.6%), and smaller than the average (6.1%, 4.8%) of service industry with small intermediate input of imported materials. As described above, smaller input coefficients of imported materials mean higher ratios of using intermediate materials domestically produced, and the imported intermediate materials are not so great when health-functional food production increases thanks to increasing final demands.

The value-added coefficient of health-functional foods was 25.2% and 25.6%, respectively, in 2010 and 2015, implying stability like the intermediate input coefficients, and reflects that the sum of the intermediate input coefficient and the value-added coefficient is 100% for each industry. Although the capital input ratio in added value products slightly decreased from 15.8% in 2010 to 14.9% in 2015, it is higher than the labor input ratio (9.3%, 10.4%), and, in particular, almost double the capital ratio (7.9%) of food and beverage products. As described above, the higher capital input ratios of the health-functional food industry imply that it depends more on production facilities, including machines and buildings, than labor input in the production process.

Table 4. Comparison of intermediate input coefficient and value added coefficient for each industry

Category	Intermediate input			Added value				Total yields
	Subtotal	Domestic materials	Imported materials	Subtotal	Labor	Capital	Others	
2010								
Agricultural, forestry and fishery products	46.7%	43.7%	3.0%	53.3%	7.2%	44.2%	1.8%	100.0%
Mineral products	43.6%	42.9%	0.7%	56.4%	18.3%	37.6%	0.5%	100.0%
Food and beverage products	84.2%	69.5%	14.7%	15.8%	7.8%	7.9%	0.1%	100.0%
Health-functio-nal foods	**74.8%**	**72.4%**	**2.5%**	**25.2%**	**9.3%**	**15.8%**	**0.1%**	**100.0%**

(Continued)

Category	Intermediate input			Added value				Total yields
	Subtotal	Domestic materials	Imported materials	Subtotal	Labor	Capital	Others	
Non-food and beverage products	77.9%	54.0%	23.9%	22.1%	8.9%	13.1%	0.1%	100.0%
SOC	69.1%	54.3%	14.8%	30.9%	19.3%	11.2%	0.4%	100.0%
Wholesale and retail	47.9%	45.1%	2.8%	52.1%	19.5%	32.1%	0.6%	100.0%
Transportation industry	66.1%	38.8%	27.3%	33.9%	17.7%	15.8%	0.4%	100.0%
Restaurants	64.6%	58.9%	5.7%	35.4%	18.7%	15.9%	0.9%	100.0%
Health and welfare	47.5%	42.3%	5.2%	52.5%	38.4%	13.9%	0.2%	100.0%
Other services	37.8%	34.4%	3.4%	62.2%	30.7%	30.6%	0.9%	100.0%
Average of manufacturing industry	78.2%	54.8%	23.4%	21.8%	8.9%	12.8%	0.1%	100.0%
Average of service industry	44.6%	38.6%	6.1%	55.4%	27.4%	27.2%	0.8%	100.0%
Average of all industries	63.6%	48.1%	15.5%	36.4%	17.1%	18.9%	0.4%	100.0%
2015								
Agricultural, forestry and fishery products	45.8%	42.9%	3.0%	54.2%	8.5%	44.7%	0.9%	100.0%
Mineral products	47.4%	46.7%	0.7%	52.6%	16.6%	35.9%	0.2%	100.0%
Food and beverages	82.9%	68.9%	14.0%	17.1%	8.9%	7.9%	0.4%	100.0%
Health-functio-nal foods	**74.4%**	**70.7%**	**3.7%**	**25.6%**	**10.4%**	**14.9%**	**0.3%**	**100.0%**
Non-food and beverage products	73.2%	51.6%	21.6%	26.8%	10.7%	15.8%	0.2%	100.0%
SOC	61.9%	48.7%	13.2%	38.1%	23.6%	14.2%	0.3%	100.0%
Wholesale and retail	47.1%	44.3%	2.8%	52.9%	28.9%	23.6%	0.4%	100.0%
Transportation industry	59.9%	38.6%	21.3%	40.1%	20.3%	19.5%	0.3%	100.0%
Restaurants	71.2%	65.8%	5.4%	28.8%	19.1%	9.0%	0.6%	100.0%
Health and welfare	47.3%	41.2%	6.1%	52.7%	39.0%	13.6%	0.1%	100.0%

(Continued)

Category	Intermediate input			Added value				Total yields
	Subtotal	Domestic materials	Imported materials	Subtotal	Labor	Capital	Others	
Other services	38.7%	35.8%	2.9%	61.3%	30.8%	29.5%	1.1%	100.0%
Average of manufacturing industry	73.9%	52.8%	21.1%	26.1%	10.6%	15.3%	0.2%	100.0%
Average of service industry	44.4%	39.7%	4.8%	55.6%	29.4%	25.3%	0.8%	100.0%
Average of all industries	59.1%	46.3%	12.8%	40.9%	20.2%	20.2%	0.5%	100.0%

Note: The income from labor in the added value sector means the employment income; the capital cost means operating surplus and consumption of fixed capital, and; others means other production taxes and subsidies.

Meanwhile, the coefficient of employment and the coefficient of job creation of the health-functional food industry decreased from 19.1 and 12.0 persons/billion in 2010 to 9.5 and 6.8 persons in 2015, respectively, implying a decrease of almost a half for five years. In particular, the coefficient of job creation was even lower than the coefficient of employment. As of 2015, the coefficient of employment and the coefficient of job creation of the health-functional food industry were equal to the average of the manufacturing industry (2.38, 2.07), but higher than the food and beverage products (2.92, 2.24) with similar features, and similar to the average of the service industry (10.03, 7.33). However, the ratio (71.8%) of the coefficient of job creation to the coefficient of employment is lower than the food and beverage products (76.4%) and the average of the manufacturing industry (87.0%) or the average of the service industry (73.1%). As described above, although the great coefficient of employment and the great coefficient of job creation of the health-functional food industry mean the greater effect of job creation, the smaller ratio of the coefficient of job creation to the coefficient of employment reflects the vulnerable industry structure centering around self-employment or small-scale enterprises.

Table 4. Comparison of employment and job creation coefficient for each industry

unit : person / billion won

Category	2010			2015		
	Coefficient of employment (A)	Coefficient of job creation (B)	B/A	Coefficient of employment (A)	Coefficient of job creation (B)	B/A
Agricultural, forestry and fishery products	28.58	2.32	8.1%	21.18	1.60	7.6%
Mineral products	4.86	4.35	89.5%	2.93	2.87	98.0%
Food and beverage products	3.49	2.39	68.5%	2.92	2.24	76.7%
Health-functional foods	**19.11**	**11.98**	**62.7%**	**9.50**	**6.82**	**71.8%**
Non-food and beverage products	2.12	1.80	84.9%	2.33	2.05	88.0%
SOC	6.06	4.47	73.8%	5.55	4.14	74.6%
Wholesale and retail	15.84	8.33	52.6%	14.11	8.12	57.5%
Transportation industry	9.60	5.02	52.3%	9.74	4.92	50.5%
Restaurants	19.48	9.28	47.6%	14.92	7.89	52.9%
Health and welfare	13.17	12.31	93.5%	13.65	12.85	94.1%
Other services	10.41	8.36	80.3%	8.23	6.79	82.5%
Average of manufacturing industry	2.22	1.84	82.9%	2.38	2.07	87.0%
Average of service industry	11.88	8.30	69.9%	10.03	7.33	73.1%
Average of all industries	6.81	4.63	68.0%	6.41	4.61	71.9%

4.2. Result of Calculated Multiplier Coefficient

The output multiplier of the health-functional food industry increased from 3.59 in 2010 to 3.67 in 2015, and this is higher than the average of the manufacturing industry (3.11) or the average of the service industry (3.45, 3.50), and the average of food and beverage products considered as a similar industry (3.42, 3.48). The added value multiplier also slightly increased from 0.25 to 0.26 during the same period, and this is higher than the average of food and beverage products (0.16, 0.17) and the average of the manufacturing industry (0.22, 0.26). The import multiplier was 0.25 in 2010 and 2015, not showing any change. This is almost half of the average of the manufacturing industry (0.51, 0.43), smaller than the food and beverage products (0.37, 0.34), and similar to the average of the service industry (0.26, 0.21) which has little imported intermediate materials.

Table 5. Comparison of intermediate input coefficient and value added coefficient for each industry

Category	Output multiplier		Added value multiplier		Import multiplier	
	2010	2015	2010	2015	2010	2015
Agricultural, forestry and fishery products	2.70	2.74	0.53	0.54	0.21	0.18
Mineral products	3.11	3.18	0.56	0.53	0.23	0.19
Food and beverage products	3.42	3.48	0.16	0.17	0.37	0.34
Health-functional foods	**3.59**	**3.67**	**0.25**	**0.26**	**0.25**	**0.25**
Non-food and beverage products	3.09	3.08	0.22	0.27	0.52	0.43
SOC	3.55	3.49	0.31	0.38	0.43	0.34
Wholesale and retail	3.35	3.67	0.52	0.53	0.23	0.20
Transportation industry	2.96	3.01	0.34	0.40	0.45	0.36
Restaurants	3.67	3.92	0.35	0.29	0.29	0.27
Health and welfare	3.99	3.88	0.52	0.53	0.31	0.26
Other services	3.47	3.43	0.62	0.61	0.23	0.18
Average of manufacturing industry	3.11	3.11	0.22	0.26	0.51	0.43
Average of service industry	3.45	3.50	0.55	0.56	0.26	0.21
Average of all industries	3.27	3.31	0.36	0.41	0.40	0.32

Meanwhile, the employment multiplier of the health-functional food industry/billion of production amount decreased from 68.7 persons in 2010 to 34.9 persons in 2015. While the job creation multiplier decreased from 43.1 to 25.0 persons during the same period, the absolute size is greater than in other industries. The employment multiplier is the average of the manufacturing industry (6.9 persons, 7.4 persons), but significantly greater than food and beverage products (11.9 persons, 10.2 persons), and similar to the average of the service industry (35.5 persons) implementing production centering around manual labor as of 2015. Furthermore, the job creation multiplier shows a result similar to the employment multiplier. As described above, greater employment and job creation multipliers of the health-functional food industry is based on the fact reflecting the industry with many employees and the coefficient of job creation, and indirect factors of greater employment and job creation multipliers in the raw material industry of agricultural, forestry and fishery products, the sales industry of wholesale and retail, and the main buyers of restaurants and health and welfare services.

Table 6. Comparison of employment and job creation multipliers of each industry

unit: persons/billion won

Category	Employment multiplier		Job creation multiplier	
	2010	2015	2010	2015
Agricultural, forestry and fishery products	77.19	58.01	6.27	4.37
Mineral products	15.10	9.31	13.51	9.10
Food and beverage products	11.92	10.19	8.17	7.79
Health-functional food	**68.71**	**34.86**	**43.06**	**25.03**
Non-food and beverage products	6.56	7.18	5.56	6.32
SOC	21.52	19.35	15.89	14.44
Wholesale and retail	53.05	51.71	27.91	29.77
Transportation industry	28.39	29.32	14.85	14.82
Restaurants	71.57	58.44	34.08	30.91
Health and welfare	52.56	52.98	49.12	49.88
Other services	35.81	28.25	28.76	23.30
Average of manufacturing industry	6.92	7.42	5.75	6.44
Average of service industry	41.11	35.51	28.91	25.94
Average of all industries	22.88	21.94	15.80	15.88

As described above, the production, added value and labor-related multiplier of the health-functional food industry greater than the average of all industries as well as the manufacturing industry or the food and beverage industry means that it has a great effect on all industries, and suggests great economic outcomes. Examination of the multiplier effect of the health-functional food industry based on the multipliers in 2015 reveals that 10 billion won of domestic demands or export as an overseas demand for the health-functional food industry contributes to direct and indirect production of 36.7 billion won across all industries, and added values of 2.6 billion won, and creating 250 jobs. Comparing this with the multiplier effect of the similar industry of food and beverage products or, the manufacturing industry and the average of all industries, the multiplier effect is shown smaller than the multiplier effect of health-functional foods, implying that it suggests more economic outcomes from the health-functional food industry as much as the difference.

4.3. Analysis of Economic Ripple Effect

This chapter uses the sales performance of the health-functional food industry to analyze two aspects of the ripple effect type on other industries and across the economy, and stages of health-functional food distribution.[9] To this end, the multiplier related to health-functional foods in 2015 for the model created above and making import and household consumption endogenous was used. The multiplier by the model only making import endogenous to extract the effect of inducing import-household consumption was also used. Meanwhile, the final demand for analysis as an extraneous variable was adjusted and used to be suitable for the analysis model by using the sales outcomes of health-functional foods in 2017 provided by the MDFS.[10]

9 The ripple effect type analysis aims to classify and examine the ripple effect into the direct effect for the health-functional food industry, the indirect effect through the input-output industry and the effect following increased consumption by increased income. The distribution stage analysis aims to examine the industry to be analyzed about each stage of raw materials, production (toll processing, provision of components, service support), sales (wholesale and retail sales), and consumption of health-functional foods.

4.3.1. Economic Effect by Each Ripple Effect Type

In 2017, the economic ripple effect by the final demand of one trillion 373.7 billion won for health-functional foods was shown 5 trillion 33.9 billion won for production, one trillion 864.3 billion won for added values, and 405.5 billion won for import. The scale of creating jobs and wage workers as the workforce was 45,828 and 26,453 persons, respectively. The ripple effect on production and added values was 3.7 and 1.4 times the final demand of the health-functional food industry, respectively.

Concerning each ripple effect path, examination of the ripple effect on production shows the direct effect of one trillion 373.7 billion won (27.3%) for the final demand; the indirect effect of one trillion 863.4 billion won (37.0%) on production of the industries related to intermediate material input for production; and the inducement effect of one trillion 802.8 billion won (35.8%) made by increased income by increasing production to promote consumption. The added value effect for each ripple effect path is shown 352.3 billion won (18.9%) for the direct effect, 745.6 billion won (40.0%) for the indirect effect, and 766.4 billion won (41.1%) for the inducement effect. Meanwhile, the employment and job creation effect is shown 13,053 and 9,370 persons, respectively, for the direct effect, 17,157 and 7,219 persons, respectively, for the indirect effect. It created 15,618 and 9,864 jobs, respectively, for the inducement effect.

10 Although the sales outcome of health-functional foods in 2017 is categorized as domestic sales (2 trillion 129.7 billion won) and export (107.7 billion won), it is not categorized for final demands and intermediate demands required for this analysis. Therefore, the final demand for domestic use (one trillion 266 billion won) was estimated from the sales outcome of health-functional foods sold in Korea, and the final demand adding the export (107.7 billion won) thereto was used on the basis of using the ratio of domestic final demand (59.4%) and domestic intermediate demand (40.6%) for the health-functional food industry in the Input-Output Table in 2015.

Table 8. Economic effect for each ripple effect path of health-functional food industry

Category		Production		Added value		Income		Employment		Job creation	
		0.1 billion won	Proportion	0.1 billion won	Proportion	0.1 billion won	Proportion	Persons	Proportion	ersons	Proportion
Direct	**Health-functio-nal foods**	**13,737**	**27.3**	**3,523**	**18.9**	**119**	**2.9**	**13,053**	**28.5**	**9,370**	**35.4**
Indirect	Agricultural, forestry and fishery products	3,678	7.3	1,992	10.7	248	6.1	7,790	17.0	587	2.2
	Mineral products	16	0.0	8	0.0	379	9.3	5	0.0	5	0.0
	Food and beverage products	1,272	2.5	218	1.2	234	5.8	372	0.8	284	1.1
	Health-functio-nal foods	1,281	2.5	329	1.8	11	0.3	1,217	2.7	874	3.3
	Non-food and beverage products	6,128	12.2	1,641	8.8	1,133	28.0	1,427	3.1	1,255	4.7
	SOC	704	1.4	268	1.4	0	0.0	390	0.9	291	1.1
	Wholesale and retail	1,833	3.6	970	5.2	21	0.5	2,585	5.6	1,488	5.6
	Transportation industry	823	1.6	330	1.8	112	2.8	801	1.7	405	1.5
	Restaurants	225	0.4	65	0.3	4	0.1	336	0.7	178	0.7
	Health and welfare	61	0.1	32	0.2	0	0.0	83	0.2	78	0.3
	Other services	2,614	5.2	1,603	8.6	283	7.0	2,151	4.7	1,774	6.7
	Subtotal	**18,634**	**37.0**	**7,456**	**40.0**	**2,425**	**59.8**	**17,157**	**37.4**	**7,219**	**27.3**
Induce-ment	Agricultural, forestry and fishery products	1,075	2.1	582	3.1	97	2.4	2,276	5.0	171	0.6
	Mineral products	10	0.0	5	0.0	241	5.9	3	0.0	3	0.0
	Food and beverage products	1,057	2.1	181	1.0	137	3.4	309	0.7	236	0.9
	Health-functio-nal foods	2,422	4.8	621	3.3	21	0.5	2,301	5.0	1,652	6.2
	Non-food and beverage products	3,541	7.0	948	5.1	718	17.7	824	1.8	725	2.7
	SOC	652	1.3	249	1.3	0	0.0	362	0.8	270	1.0

(Continued)

Category		Production		Added value		Income		Employment		Job creation	
		0.1 billion won	Proportion	0.1 billion won	Proportion	0.1 billion won	Proportion	Persons	Proportion	ersons	Proportion
Induce-ment	Wholesale and retail	1,554	3.1	822	4.4	10	0.3	2,193	4.8	1,262	4.8
	Transportation industry	611	1.2	245	1.3	77	1.9	595	1.3	301	1.1
	restaurants	933	1.9	268	1.4	4	0.1	1,392	3.0	736	2.8
	health and welfare	523	1.0	276	1.5	0	0.0	714	1.6	672	2.5
	Other services	5,651	11.2	3,466	18.6	205	5.1	4,650	10.1	3,835	14.5
	Subtotal	**18,028**	**35.8**	**7,664**	**41.1**	**1,510**	**37.2**	**15,618**	**34.1**	**9,864**	**37.3**
Total		**50,399**	**100.0**	**18,643**	**100.0**	**4,055**	**100.0**	**45,828**	**100.0**	**26,453**	**100.0**

Table 9. Detailed effect of added value for each ripple effect path of health-functional food industry

unit: 0.1 billion won

Category		Wage	Capital cost	Tax	Total
Direct	**Health-functional foods**	**1,425**	**2,052**	**47**	**3,523**
Indirect	Agricultural, forestry and fishery products	314	1,644	34	1,992
	Mineral products	3	6	0	8
	Food and beverage products	113	100	4	218
	Health-functional food	133	191	4	329
	Non-food and beverage products	658	968	14	1,641
	SOC	166	100	2	268
	Wholesale and retail	529	433	8	970
	Transportation industry	167	161	2	330
	Restaurants	43	20	1	65
	Health and welfare	24	8	0	32
	Other services	804	770	29	1,603
	Subtotal	**2,955**	**4,401**	**100**	**7,456**
Induce-ment	Agricultural, forestry and fishery products	92	480	10	582
	Mineral products	2	3	0	5

(Continued)

Category		Wage	Capital cost	Tax	Total
Induce-ment	Food and beverage products	94	83	4	181
	Health-functional food	251	362	8	621
	Non-food and beverage products	380	559	8	948
	SOC	154	93	2	249
	Wholesale and retail	449	367	7	822
	Transportation industry	124	119	2	245
	Restaurants	178	84	6	268
	Health and welfare	204	71	1	276
	Other services	1,738	1,665	62	3,466
	Subtotal	**3,667**	**3,888**	**109**	**7,664**
Total		**8,046**	**10,340**	**256**	**18,643**

4.3.2. Economic Effect in Each Distribution Stage

The ripple effect by each distribution stage with the final demand for health-functional foods of one trillion 373.7 billion was generally for stages of production, followed by raw materials, sales, and consumption. The production multiplier effect was for the stages of raw materials of 708.2 billion won (14.1%), production of 3 trillion 675.4 billion won (72.9%), sales of 482.1 billion won (9.6%), and consumption of 174.2 billion won (3.5%). The added value effect was for the stages of raw materials of 297.3 billion won (15.9%), production of one trillion 266.2 billion won (67.9%), sales of 236.7 billion won (12.7%), and consumption of 64.1 billion won (3.4%). The import effect was 311.1 billion won considered not significant in the production stage but accounted for 76.7% in the entire effects. Meanwhile, the employment and job creation effect was for the stages of raw materials of 10,746 and 1,279 persons, production of 26,383 and 20,054 persons, sales of 6,174 and 3,456 persons and consumption of 2,525 and 1,664 persons. The employment effect showed a higher proportion of 23.4% for the stage of raw materials, and the job creation effect showed a lower proportion of 4.8% for the stage of raw materials. This is the result reflecting the unique labor input structure of the agriculture, forestry and fishery industry playing a vital key role as a raw material Industry.[11]

Table 10. Economic effect in each distribution stage of health-functional food industry

Category		Production		Added value		Import		Employment		Job creation	
		0.1 billion won	Proportion	0.1 billion won	Proportion	0.1 billion won	Proportion	Persons	Proportion	ersons	Proportion
Raw material	Agricultural, forestry and fishery products	4,753	9.4	2,574	13.8	345	8.5	10,065	22.0	758	2.9
	Food and beverage products	2,329	4.6	399	2.1	371	9.2	681	1.5	521	2.0
	Subtotal	**7,082**	**14.1**	**2,973**	**15.9**	**716**	**17.7**	**10,746**	**23.4**	**1,279**	**4.8**
Produc-tion	Mineral products	25	0.1	13	0.1	620	15.3	7	0.0	7	0.0
	Health-functional food	17,440	34.6	4,473	24.0	151	3.7	16,572	36.2	11,896	45.0
	Non-food and beverage products	9,669	19.2	2,589	13.9	1,851	45.7	2,251	4.9	1,981	7.5
	SOC	1,355	2.7	517	2.8	1	0.0	752	1.6	561	2.1
	Other services	8,265	16.4	5,069	27.2	488	12.0	6,800	14.8	5,608	21.2
	Subtotal	**36,754**	**72.9**	**12,662**	**67.9**	**3,111**	**76.7**	**26,383**	**57.6**	**20,054**	**75.8**
Sale	Wholesale and retail	3,387	6.7	1,792	9.6	31	0.8	4,777	10.4	2,750	10.4
	Transportation industry	1,434	2.8	575	3.1	189	4.7	1,396	3.0	706	2.7
	Subtotal	**4,821**	**9.6**	**2,367**	**12.7**	**220**	**5.4**	**6,174**	**13.5**	**3,456**	**13.1**
Consump-tion	Restaurants	1,158	2.3	333	1.8	7	0.2	1,728	3.8	914	3.5
	Health and welfare	584	1.2	308	1.7	0	0.0	797	1.7	751	2.8
	Subtotal	**1,742**	**3.5**	**641**	**3.4**	**8**	**0.2**	**2,525**	**5.5**	**1,664**	**6.3**
All industries		**50,399**	**100.0**	**18,643**	**100.0**	**4,055**	**100.0**	**45,828**	**100.0**	**26,453**	**100.0**

11 According to the coefficient of employment and the coefficient of job creation for each industry analyzed above, the ratio of the job creation multiplier to the employment multiplier in the agricultural, forestry and fishery sector as of 2015 was 7.5%, which is about 1/10 the average of all industries of 71.9% or health-functional foods of 71.8%. The unique labor input structure of the agricultural, forestry and fishery sector raise the proportion of the raw material stage in the employment effect, but lowers the proportion of the raw material stage in the job creation effect.

Table 11. Detailed effect of added value for each ripple effect path of health-functional food industry

unit: 0.1 billion won

Category		Wage	Capital cost	Tax	Total
Raw material	Agricultural, forestry and fishery products	406	2,124	44	2,574
	Food and beverage products	208	183	8	399
	Subtotal	**614**	**2,307**	**52**	**2,973**
Produc-tion	Mineral products	4	9	0	13
	Health-functional food	1,809	2,605	59	4,473
	Non-food and beverage products	1,039	1,528	23	2,589
	SOC	320	193	4	517
	Other services	2,542	2,436	91	5,069
	Subtotal	**5,714**	**6,770**	**177**	**12,662**
Sale	Wholesale and retail	977	800	15	1,792
	Transportation industry	292	280	4	575
	Subtotal	**1,269**	**1,080**	**19**	**2,367**
Consump-tion	Restaurants	222	104	7	333
	Health and welfare	228	80	1	308
	Subtotal	**449**	**184**	**8**	**641**
All industries		**8,046**	**10,340**	**256**	**18,643**

5. Summary and Conclusion

This study used a model making household consumption endogenous to measure the ripple effect of the health-functional food industry on the national economy and make an input-output analysis. A model was built to measure the economic ripple effect including the inducement effect as well as direct and indirect effects utilizing the model making household consumption endogenous.

The industrial input-output analysis reveals the health-functional food industry with a small imported material input coefficient to show a higher rate of domestically produced intermediate materials and supply input materials for production from Korea. Although the coefficient of employment and the coefficient of job creation were higher than other industry to imply great effects of employment or job creation, the ratio of the coefficient of job creation to the coefficient of employment was lower to show a vulnerable Industry structure with self-employment or small-scale enterprises.

As of 2015, while the output multiplier of the health-functional food industry was 3.67, higher than the average of all industries of 3.31, the value-added coefficient was 0.26, lower than the average of all industries of 0.41. The employment multiplier and the job creation multiplier were 34.9 and 25.0 persons which are greater than 21.9 and 15.9 persons of the average of all industries. As described above, the reason for greater employment and job creation multipliers of the health-functional food industry is that the industry has greater employment and job creation effects, and the related industries including agricultural, forestry and fishery products and the sales industry including wholesale and retail, restaurants, health and welfare services have greater employment and job creation effects. The forward/backward linkage coefficient of the health-functional food industry was 0.39 and 1.11, respectively, implying the backward linkage coefficient is about three times greater than the forward linkage coefficient. This implies that the production of health-functional foods affects the production of other industries rather than being affected by production changes in other industries.

On the other hand, the results of the simulation through the actual status data show that the economic ripple effect by one trillion 373.7 billion won of the final demand of the health-functional food industry was shown 5 trillion 33.9 billion won for production, one trillion 864.3 billion won for added values, and 405.5 billion won for import as of 2017. The employment and job creation scale was shown 45,828 and 26,453 persons, respectively. Concerning each ripple effect path, the direct production effect was one trillion 373.7 billion won (27.3%) for the final demand; the indirect effect was one trillion 863.4 billion won

(37.0%), and; the inducement effect was one trillion 802.8 billion won (35.8%). The ripple effect for each distribution stage was 708.2 billion won (14.1%) for raw materials; 3 trillion 675.4 billion won (72.9%) for production; 482.1 billion won (9.6%) for sales; and 174.2 billion won (3.5%) for consumption.

Generalizing the input-output analysis result described above, the health-functional food industry procures most intermediate materials produced in Korea for producing health-functional foods, and greater effects of employment and job creation are shown. Moreover, it has higher backward linkage effect to have greater economic ripple effects on industrial development of Korea than other industries as the health-functional food industry grows. However, many small-scale enterprises in the industry mean a vulnerable structure.

For this study, input-output analysis was made about the impact on the Korean industry as the fast-growing health-functional food industry recently grows bigger. It is shown that the growing health-functional food industry has a positive impact on employment or the backward linkage industry. Therefore, supporting the health-functional food industry from the national perspective will play a positive role in the development of the national economy. From these findings, if the nation seeks more active support and nurturing measures for the health functional food industry that is rapidly growing in demand, not only will the health functional food industry itself develop, but also the national issues of job creation and other industries. By contributing significantly to development, it is expected to play a positive role in the development of the national economy.

This study is distinguishable from the existing studies by applying the Input-Output model to the economic effect analysis of health functional foods, which can analyze the inducement effect besides direct and indirect effects by considering endogenous income and consumption at the same time. Additionally, this analysis estimates the employment effect of health functional food industry which is not classified in the employment table of the Bank of Korea. In terms of policy utilization, not only the import goods and domestic goods of the intermediate input coefficient are classified, but also the added value coefficient was subdivided into labor, capital and other parts. Simulation is fulfilled using recent actual sales data of health functional foods to get realistic results, so it is possible to utilize the results to recommend various policies by evaluating the effects of types of ripples and distribution stages.

Despite such distinction, this study has limitations in the following points. First, in the process of estimating the employment and the employer of health functional foods, there is a possibility of some error by using the proportion of the salary by industry to convert the standard of full-time workers. Second, the comparative static analysis between the two periods in 2010 and 2015 considered the change according to the time flow but did not consider the complete dynamic effect. Third, there will be much difference in the structure of the health functional food industry by region. However, the regional analysis is not carried out due to the limitation of the use of the regional industry-related table. It is expected to be improved in the future studies.

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