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The Economic Effects of the Home Beauty Device Industry in Korea: An Input-Output Analysis

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Abstract: *As global populations age, interest in well-being, beauty, and health enhancement has increased, leading to growth in the home beauty device market. This study investigates the economic impacts of the home beauty device industry in Korea by employing an exogenous demand-driven model based on the latest 2020 Input-Output (IO) table. The analysis reveals that the home beauty device industry generates a production-inducing effect of 1.7078 KRW and a value-added creation effect of 0.9352 KRW for additional 1 KRW increase in industry output. Moreover, the industry is associated with employment- and labor-inducement effects of estimated 5.4240 and 4.4589 persons, respectively, for every 1 billion KRW increase in output. However, the inter-industry linkage effects, encompassing both forward and backward linkages, are relatively small compared to other industries. These findings provide valuable quantitative insights for policymakers and stakeholders to help develop strategic initiatives that support and enhance the growth potential of Korea's home beauty device industry.*

Keywords: Home Beauty Device; Personal Beauty Electronics; Input-Output Analysis; Demand-Driven Model; Economic Effect

1. Introduction

During the COVID-19 pandemic, the home beauty device (personal beauty equipment) market emerged as a substitute for dermatology clinics, experiencing not just a temporary trend but significant growth even after the pandemic. Globally, as societies face aging populations, the home beauty device industry, still in its early stages, is recognized as a high-value-added sector with immense growth potential [1, 2]. In Korea, the domestic market for home beauty devices expanded dramatically from 80 billion KRW in 2013 to 1.6 trillion KRW in 2022, and on a global scale, the market is projected to grow from $14 billion in 2022 to $89.9 billion by 2030, achieving a compound annual growth rate (CAGR) of 26.1% [3]. This expansion is primarily driven by the rising demand for anti-aging solutions, which are increasingly sought after by aging demographics. Against this backdrop, it is important to evaluate the economic effects of the home beauty device industry.

The home beauty device market, a technology-intensive and high-value-added industry, has attracted diverse industry players, including pharmaceutical companies, cosmetics firms, and specialized medical device manufacturers. Home beauty devices are electronic products designed for facial rejuvenation and skin improvement, utilizing technologies such as radiofrequency, LED, microcurrent, direct current, alternating current, or ultrasonic waves [4, 5]. As the home beauty device market undergoes rapid growth, it is expected to evolve beyond providing simple beauty benefits. Especially with the global spread and popularity of Korean cultural exports like K-drama and K-pop, international interest in Korean beauty products and practices has surged significantly [6]. Consequently, innovations in "beauty tech", leveraging artificial intelligence (AI), big data, and app integration, are expected to redefine this sector [7]. Moreover, the diffusion of home beauty devices is not confined to manufacturing effects alone but is increasingly intertwined with the media and content industries. Through integration with social media platforms (SNS), personalized digital applications, and

visual/aesthetic media, these devices contribute to the global dissemination of K-beauty content [8-10]. This convergence generates added value by linking physical products with cultural exports, suggesting the potential of the industry as a new frontier of media-convergent innovation and a strategic sector for Korea's content-driven economic growth.

Despite this rapid growth and industry prominence, existing literature lacks comprehensive studies specifically evaluating the economic impacts of the home beauty device industry. To bridge this gap, this study reviews prior research on closely related industries, such as general beauty, cosmetics, and medical devices, to accurately define and classify the home beauty device industry. This classification aligns industry-specific product categories with Input-Output (IO) product codes and Harmonized System (HS) codes using the most recently published 2020 IO Table [11]. By employing the externalization method within a demand-driven IO model, the study isolates the home beauty device sector from the domestic transaction table. This method allows for a clear identification and quantification of direct industry effects and the indirect inter-industry impacts, offering precise insights into how the home beauty device industry influences and interacts with other sectors. Consequently, this study represents the first systematic effort to clearly define and quantitatively assess the economic implications of Korea's home beauty device industry through its integration into the IO tables and HS classification system.

As home beauty devices shift from optional skincare tools to essential products, particularly for female consumers, assessing their economic impact on the Korean economy is critical for developing policies and strategies to position the industry as a national growth engine. Moreover, while home beauty devices are currently not regulated as medical devices under Korean law, this study offers policy insights that provide guidance to the future regulatory frameworks.

This paper is structured as follows: Section 2 reviews existing studies on the beauty industry, medical devices, and other relevant sectors closely linked to the home beauty device industry. Section 3 presents the theoretical framework including the exogeneous demand-driven IO analysis model and defines home beauty device industry. Section 4 analyzes the economic effects of the home beauty device industry including production-inducing effect, value-added creation effect, employment and labor inducing effects, and interlinkage effects. Finally, Section 5 concludes the findings and discusses policy implications.

2. Literature Review

The home beauty device industry has experienced rapid growth, particularly in the aftermath of the COVID-19 pandemic [12]. While previous studies have explored company performance, industry trends, effectiveness, and development strategies related to home beauty devices [3, 4], [7], [13-15], there is a lack of research quantitatively analyzing the economic impacts of this emerging sector.

[4] investigated the efficacy and consumer perception of home beauty devices in China, highlighting their increasing popularity driven by factors such as convenience and cost-effectiveness. While their analysis primarily addressed clinical outcomes and safety evaluations, the findings underscore the rapidly increasing consumer demand and significant global market potential for home beauty technologies. The study also suggested opportunities for collaboration between the home beauty device industry and other interconnected sectors, specifically recommending the exploration of potential benefits arising from the integration of traditional Chinese medicine principles into home beauty devices. This inter-industry collaboration perspective provides valuable insights for examining economic linkages and sectoral interactions in the home beauty device industry.

Studies analyzing the economic effects of Korea's beauty and cosmetics industries include [16-18]. Specifically, [16] analyzed the economic effects of the cosmetics industry by classifying "cosmetics" as a distinct sector within the 2010 IO Table. Similarly, [17] used the 2009 IO Table to categorize three sectors—"cosmetics and toothpaste", "soap and detergents", and "barbering and beauty"—as components of the broader beauty industry. Their analysis encompassed both beauty-related services and manufacturing sectors, revealing that the beauty industry exhibited a production-inducing coefficient of 1.810, a value-added-inducing coefficient of 0.728, an income-inducing coefficient of 0.293, a production tax-inducing coefficient of 0.124, and a labor-inducing coefficient of 0.039.

Studies analyzing the economic effects of the medical device industry include [19-21]. [19] broadly defined the medical device industry, including therapeutic equipment, diagnostic instruments, dental and orthopedic devices, body correction tools, and radiotherapy systems. Using the "medical devices" category within the 2009 IO Table, they analyzed the economic effects of the medical device industry. Their findings revealed that while the production-inducing and value-added effects initially declined from 1995 to 2000, they rebounded significantly in subsequent years. However, the employment-inducing effects showed a consistent downward trend.

Similarly, [20] analyzed the investment effects of Korea's medical and measuring device industry using the "medical and measuring devices" subcategory in the 2009 IO Table. The results found that the economic effects of the medical and measuring device industry were relatively larger than the average of all industries. However, in terms of value-added effects, the industry was comparatively smaller. As with [19, 20] noted that the industry's employment and job-creation effects were relatively lower than the average for all industries.

Furthermore, existing literature investigates sustainability considerations within medical devices and cosmetics sectors. [22] examined circular business models in the medical device industry to promote sustainability by extending product lifecycles and reducing environmental footprints, whereas [23] specifically focused on integrating sustainability criteria within supplier selection processes to achieve sustainable manufacturing in the same industry. Meanwhile, [24] highlighted the growing prioritization of sustainability within the cosmetics and personal care industry, emphasizing environmentally responsible sourcing, production, and marketing practices.

However, there are limited or no studies specifically addressing the sustainability or economic impacts of the home beauty device industry. Therefore, by synthesizing these related studies, this study aims to accurately define and quantitatively evaluate the economic impacts of the home beauty device industry, and provide relevant, evidence-based policy recommendations for industry stakeholders and policymakers.

3. Model Specification

3.1 Demand-driven IO Model

Input-Output (IO) analysis is a linear inter-sectoral model that examines how changes in the output of one sector affect the demand for the outputs of other sectors [25, 26]. By focusing on the relationships between the sales and purchases of input factors, IO analysis provides a detailed representation of economic interdependencies, embodying the characteristics of a general equilibrium model. This approach is particularly effective for analyzing inter-industrial relationships, which are often overlooked in traditional macroeconomic analyses [27]. This study adopts a demand-driven model using the domestic transaction table with a non-competitive import type IO table, which distinguishes between domestic and imported inputs under the realistic assumption that these inputs are heterogeneous across industries. Furthermore, by treating the home beauty device industry as an exogenous sector, the analysis quantifies the induced effects generated by shocks such as new investment or industry expansion, enabling an analysis of how this industry influences endogenous economic sectors. In other words, changes in its final demand are isolated from the endogenous production structure of other industries, thereby allowing the analysis to clearly distinguish between direct effects within the home beauty device sector and indirect spillovers across the rest of the economy. The basic demand-driven IO model is expressed as follows:

$$X = (I - A)^{-1}Y \tag{1}$$

, where X is the total output vector, I is the identity matrix with diagonal elements of 1 and all other elements 0, A is the input coefficient matrix, and Y is the final demand vector. By applying externalization, it enables to distinguish the impact of a specific sector's output and its effect on other industries, rather than analyzing total demand [27]. By externalizing the home beauty device industry (denoted as H), and adding a superscript 'e' to indicate externalization, the production-inducing effect can be calculated as follows:

$$\Delta X = \Delta X_H + \Delta X_H^e = \Delta Y_H + (I - A^e)^{-1}(A_H^e \Delta Y_H) \tag{2}$$

, where ΔX represents the change in total industry output, comprising changes within the home beauty device industry itself (ΔX_H), and changes induced in other industries (ΔX_H^e). Here, the matrix $(I - A^e)^{-1}$ is the domestic production multiplier matrix (Leontief inverse matrix), excluding the home beauty device industry. The vector A_H^e contains the input coefficients of other industries supplying the home beauty device industry, and ΔY_H represents a unitary increase in the final demand of the home beauty device industry.

Specifically, the direct effects (ΔY_H) correspond to the immediate economic changes within the home beauty device industry itself due to external demand changes, therefore, ΔY_H equals ΔX_H. Indirect effects, captured by $(I - A^e)^{-1}(A_H^e \Delta Y_H)$, denote cascading impacts on other sectors linked through the production chain as a result of changes in the exogenous industry.

Similarly, the total value-added creation effect (ΔW) is calculated as follows:

$$\Delta W = \Delta W_H + \Delta W_H^e = \widehat{v_H} \Delta Y_H + \widehat{v_H^e}(I - A^e)^{-1}(A_H^e \Delta Y_H) \tag{3}$$

Here, ΔW_H represents value-added created directly within the home beauty device industry, and ΔW_H^e is the value-added generated indirectly in other sectors. $\widehat{v_H}$ is the value-added coefficient of the home beauty device industry, whereas $\widehat{v_H^e}$ is the diagonal matrix of value-added coefficients excluding the home beauty device industry. Value-added coefficient is defined as the ratio of value-added to final demand, indicating the amount of value-added directly and indirectly created by one unit of final demand in the home beauty device industry.

The employment-inducing effect (ΔN) is calculated similarly:

$$\Delta N = \Delta N_H + \Delta N_H^e = \widehat{n_H}\Delta Y_H + \widehat{n_H^e}(I - A^e)^{-1}(A_H^e \Delta Y_H) \quad (4)$$

, where ΔN_H and ΔN_H^e indicate direct employment effect within the home beauty device industry, and indirect employment effects across other sectors, respectively. $\widehat{n_H}$ is the employment coefficient of the home beauty device industry, while $\widehat{n_H^e}$ is a diagonal matrix representing sector-specific employment coefficients. Employment coefficient is defined as the ratio of the number of employed workers (including self-employed, wage and salary workers, and unpaid family workers) to total output. $\widehat{n^e}(I - A^e)^{-1}$ represents the employment-inducing coefficient.

Similarly, using labor coefficient, the labor-inducing effect (ΔL) can be calculated:

$$\Delta L = \Delta L_H + \Delta L_H^e = \widehat{l_H}\Delta Y_H + \widehat{l_H^e}(I - A^e)^{-1}(A_H^e \Delta Y_H) \quad (5)$$

, where ΔL_H and ΔL_H^e indicate direct labor effect within the home beauty device industry, and indirect labor effects across other sectors, respectively. $\widehat{l_H}$ is the labor coefficient of the home beauty device industry, while $\widehat{l_H^e}$ is a diagonal matrix representing sector-specific labor coefficients. Labor coefficient is defined as the ratio of the number of wage and salary workers to total output. $\widehat{l^e}(I - A^e)^{-1}$ represents the labor-inducing coefficient. Since the employment and labor tables are not provided for the fundamental sectors, a separate calculation process is required to estimate the number of employees by fundamental sector. Therefore, in this study, the number of employed and wage workers in fundamental sector industries is calculated by multiplying the number of employed and wage workers in detailed industries by the share of employee compensation in each fundamental sector [28].

Additionally, forward and backward linkage effects are analyzed using the index of sensitivity dispersion (ISD) and the index of power dispersion (IPD), respectively [29]. These indices provide insights into sectoral interconnectedness and are defined as follows:

$$ISD = \frac{\frac{1}{n}\sum_{j=1}^{n} a_{ij}}{\frac{1}{n^2}\sum_{i=1}^{n}\sum_{j=1}^{n} a_{ij}} \quad (6)$$

$$IPD = \frac{\frac{1}{n}\sum_{i=1}^{n} a_{ij}}{\frac{1}{n^2}\sum_{i=1}^{n}\sum_{j=1}^{n} a_{ij}} \quad (7)$$

Here, a_{ij} denotes the element in the i-th row and j-th column of the production-inducing coefficient matrix. The ISD measures the extent to which an industry supplies intermediate goods to other industries compared to the economy-wide average, indicating its sensitivity to fluctuations in other sectors' demand. When ISD is high, the home beauty device industry is a major supplier of inputs of other industries. Conversely, the IPD measures how extensively an industry demands intermediate inputs from other sectors relative to the average, indicating its overall dependency on inputs from other sectors. When IPD is high, the home beauty device industry is a major consumer of outputs of other industries.

3.2 Home Beauty Device Industry Classification

Home beauty devices refer to electric personal beauty equipment designed to address skin concerns or improve skin conditions through various technologies, including radiofrequency, LED, microcurrent, direct current (galvanic, iontophoresis), alternating current (low, medium, or high frequency), and ultrasonic waves [4, 5]. Unlike medical devices that are regulated under Korea's Medical Device Act, home beauty devices are not subject to medical device certification. Instead, these devices typically require KC certification, which ensures compliance with safety standards for electrical and household products as well as broadcasting and telecommunications equipment. In contrast, medical devices intended for hospital use are categorized as "Medical Devices (3611)" in the 2020 IO Table.

In the HS tariff schedule, home beauty devices are classified under HS code 8543.70, which encompasses "Electrical machines and apparatus, having individual functions, not specified or included elsewhere in this chapter". This category includes electrical beauty appliances (HS code 8543.70.2020 in U.S. extension), ionizers, audio mixers, and equalizers. On the other hand, medical devices are classified under HS code 9018.90, which covers "Instruments and appliances used in medical, surgical, dental or veterinary sciences". Furthermore, the classification under HS code 8543.70.2020 is based on devices "operated by the properties or effects of electricity", such as those activated by electronic effects or heating (excluding devices classified under HS codes 8505, 8511 to 8518, 8525 to 8531, and 8543). Based on these specifications, home beauty devices are distinct from medical devices.

The detailed industry classification process is as follows. First, the 2020 IO-HS code concordance table was used to match the six-digit HS code 8543.70 with the corresponding four-digit IO product codes. Next, prior studies and the technological and functional characteristics of home beauty devices were reviewed to refine the classification at the level of HS 8543.70.2020 and to delineate the scope of the home beauty device industry. Based on this process, the industry was classified and externalized in the 2020 IO Table under the following sectors: 'Other Wireless Communication Equipment and Broadcasting Equipment (3519)', 'Measuring and Analytical Instruments (3612)', 'Automatic Regulation and Control Instruments (3613)' and 'Other Household Electric Appliances (3759)'. These sectors capture the electronic, measurement, control, and household appliance characteristics that collectively define home beauty devices.

This study utilizes the most recent 2020 IO Table, released by the Bank of Korea on April 29, 2024. The updated IO Table incorporates modifications to industrial frameworks and input structures since the 2015 IO Table, integrating comprehensive data from the 2020 Census on Establishments. Consequently, this table offers a more precise and detailed representation of the domestic economic structure, classified into 380 fundamental sectors [11]. For analytical clarity and consistency, this study adopts the Bank of Korea's 33-sector macro-classification scheme, explicitly incorporating the home beauty device industry as an additional, newly defined 34th sector. The reclassified macro-sectors (34 sectors) are presented in Table 1 below.

Table 1. Reclassified 34 Sector Industry Classification

No	Industry	No	Industry	No	Industry
1	Agricultural, forest, and fishery goods	13	Machinery and equipment	25	Real estate services
2	Mining and quarried goods	14	Transport equipment	26	Professional, scientific, and technical services
3	Food, beverages and tobacco products	15	Other manufactured products	27	Business support services
4	Textile and leather products	16	Manufacturing services and repair services of industrial equipment	28	Public administration, defense, and social security services
5	Wood and paper products, printing and reproduction of recorded media	17	Electricity, gas and steam supply	29	Education services
6	Petroleum and coal products	18	Water supply, sewage, waste treatment and disposal services	30	Health and social care services
7	Chemical products	19	Construction	31	Art, sports, and leisure services
8	Non-metallic mineral products	20	Wholesale and retail trade and commodity brokerage services	32	Other services
9	Basic metal products	21	Transportation	33	Others
10	Fabricated metal products, except machinery and furniture	22	Food services and accommodation	34	Home beauty device
11	Computing machinery, electronic equipment and optical instruments	23	Communications and broadcasting	-	-
12	Electrical equipment	24	Finance and insurance	-	-

4. Estimation Results

Using the Bank of Korea's 2020 IO Table, the production-inducing, value-added creation, employment-inducing, and labor-inducing effects of the home beauty device industry are presented in Table 2[1]. The results clearly differentiate between direct effects, arising within the industry itself, and indirect effects, representing cascading impacts on other related industries.

First, the total production-inducing effect of the home beauty device industry is estimated at 1.7078 KRW for 1 KRW of additional demand generated in the industry. This consists of a direct effect of 1 KRW within the home beauty device industry and an indirect effect of 0.7078 KRW across other industries. Among the sectors benefiting significantly from these indirect effects, the "Computing machinery, electronic equipment, and optical instruments (sector 11)" sector contributes most substantially, generating 0.1395 KRW, followed by "Wholesale and retail trade and commodity brokerage services (sector 20)" at 0.0771 KRW, and "Manufacturing services and repair services of industrial equipment (sector 16)" at 0.0687 KRW. These results highlight robust linkages between the home beauty device industry and sectors characterized by technology intensity and service orientation.

Table 2. Results of the Home Beauty Device Industry-based Input-Output Analysis

No	Industry Classification	Production-inducing effect		Value-added creation effect		Employment-inducing effect		Labor-inducing effect	
		Value	Rank	Value	Rank	Value	Rank	Value	Rank
1	Agricultural, forest, and fishery goods	0.0027	25	0.0014	25	0.0558	14	0.0043	30
2	Mining and quarried goods	0.0005	33	0.0002	32	0.0016	31	0.0016	31
3	Food, beverages and tobacco products	0.0061	20	0.0023	22	0.0143	25	0.0118	23
4	Textile and leather products	0.0059	21	0.0028	19	0.0183	22	0.0144	21
5	Wood and paper products, printing and reproduction of recorded media	0.0078	17	0.0032	17	0.0268	16	0.0220	16
6	Petroleum and coal products	0.0086	16	0.0067	15	0.0009	32	0.0008	32
7	Chemical products	0.0557	4	0.0281	5	0.0851	11	0.0799	9
8	Non-metallic mineral products	0.0050	24	0.0019	24	0.0126	26	0.0108	26
9	Basic metal products	0.0289	9	0.0150	9	0.0268	17	0.0259	14
10	Fabricated metal products, except machinery and furniture	0.0350	7	0.0133	12	0.1108	8	0.0957	8
11	Computing machinery, electronic equipment and optical instruments	0.1395	1	0.0859	1	0.1656	6	0.1583	5
12	Electrical equipment	0.0400	6	0.0176	7	0.0804	12	0.0741	11
13	Machinery and equipment	0.0070	18	0.0030	18	0.0191	20	0.0173	18
14	Transport equipment	0.0069	19	0.0022	23	0.0112	27	0.0109	25
15	Other manufactured products	0.0013	30	0.0005	31	0.0065	30	0.0045	29
16	Manufacturing services and repair services of industrial equipment	0.0687	3	0.0378	3	0.4056	2	0.3602	2
17	Electricity, gas and steam supply	0.0202	12	0.0142	10	0.0150	23	0.0146	20

[1] Because the 11th KSIC revision was implemented in 2024, strict comparisons with pre-2020 tables are not feasible. However, 2021 and 2022 extended IO tables allow partial verification, therefore, additional analysis results are presented in the Appendix. The findings confirm that the home beauty device industry's economic effects remain consistent across years.

18	Water supply, sewage, waste treatment and disposal services	0.0050	23	0.0026	20	0.0282	15	0.0230	15
19	Construction	0.0023	26	0.0011	27	0.0145	24	0.0117	24
20	Wholesale and retail trade and commodity brokerage services	0.0771	2	0.0442	2	0.7063	1	0.4314	1
21	Transportation	0.0298	8	0.0166	8	0.2734	4	0.1535	6
22	Food services and accommodation	0.0132	14	0.0049	16	0.1436	7	0.0769	10
23	Communications and broadcasting	0.0167	13	0.0104	13	0.0718	13	0.0646	12
24	Finance and insurance	0.0289	10	0.0185	6	0.1011	9	0.0982	7
25	Real estate services	0.0116	15	0.0087	14	0.0246	18	0.0158	19
26	Professional, scientific, and technical services	0.0509	5	0.0293	4	0.3014	3	0.2652	3
27	Business support services	0.0202	11	0.0138	11	0.2129	5	0.1979	4
28	Public administration, defense, and social security services	0.0008	32	0.0006	30	0.0073	29	0.0073	28
29	Education services	0.0010	31	0.0007	29	0.0107	28	0.0086	27
30	Health and social care services	0.0018	28	0.0012	26	0.0183	21	0.0174	17
31	Art, sports, and leisure services	0.0019	27	0.0011	28	0.0193	19	0.0119	22
32	Other services	0.0055	22	0.0026	21	0.0900	10	0.0505	13
33	Others	0.0014	29	0.0000	33	0.0000	33	0.0000	33
Sum of indirect effects of other industries (A)		0.7078		0.3925		3.0795		2.3410	
Effect of home beauty device industry (B)		1.0000		0.5427		2.3445		2.1179	
Total (A+B)		1.7078		0.9352		5.4240		4.4589	

Moreover, the value-added creation effect of the home beauty device industry is calculated at 0.9352 KRW for every 1 KRW of production. This includes 0.5427 KRW of direct value-added generated within the industry and 0.3925 KRW of indirect value-added from other industries. The top contributing sectors for indirect value-added include “Computing machinery, electronic equipment and optical instruments (sector 11)” with 0.0859 KRW, “Wholesale and retail trade and commodity brokerage services (sector 20)” with 0.0442 KRW, and “Manufacturing services and repair services of industrial equipment (sector 16)” with 0.0378 KRW. These results highlight the substantial contributions of high-tech and service-oriented sectors to the overall value-added effects of the home beauty device industry.

In addition, the employment-inducing effect reveals that an additional production of 1 billion KRW in the home beauty device industry creates 5.4240 jobs across the national economy. Of these, 2.3445 jobs are generated directly within the industry, while 3.0795 jobs are created indirectly in other industries. The “Wholesale and retail trade and commodity brokerage services (sector 20)” sector ranks highest in indirect employment creation, generating 0.7063 jobs per billion KRW. The “Manufacturing services and repair services of industrial equipment (sector 16)” sector follows with 0.4056 jobs, and the “Professional, scientific, and technical services (sector 26)” sector contributes 0.3014 jobs. These results demonstrate the industry’s capacity to support substantial employment across various economic sectors.

Furthermore, the labor-inducing effect is estimated at 4.4589 workers per 1 billion KRW increase in industry output, comprising 2.1179 workers within the industry and 2.3410 workers from other industries. Consistent with the employment-inducing effect, the “Wholesale and retail trade and commodity brokerage services (sector 20)” sector contributes most significantly to indirect labor generation, generating 0.4314 workers per billion KRW, followed by “Manufacturing services and repair services of industrial equipment (sector 16)” at 0.3602 workers, and “Professional, scientific, and technical services (sector 26)” at 0.2652 workers. These results suggest that the majority of jobs created through the expansion of the home beauty device industry consist of wage and salary workers.

Comparatively, the production-inducing effect (1.7078 KRW) found in this study is slightly lower than the coefficient of 1.810 reported by [17] for Korea's beauty industry. However, the value-added creation coefficient of 0.9352 KRW surpasses their estimate of 0.728, reflecting a higher economic contribution by this emerging sector. Similarly, the employment and labor induction of 5.4240 jobs and 4.4589 workers per 1 billion KRW significantly exceeds the labor inducement coefficient of 0.039 reported by [17], indicating that the home beauty device industry has stronger employment generation capabilities. These differences can be attributed to the industry's stronger integration with advanced manufacturing and high-value-added sectors, notably technology and service-oriented industries.

Moreover, while the home beauty device industry exhibits higher value-added creation compared to industry averages, relevant high-tech sectors, such as medical and measuring device industries, typically demonstrate lower value-added coefficients [19, 20]. Specifically, [19] reported a value-added creation coefficient of 0.5089 for the medical device industry, and [20] reported 0.6498 for the medical and measuring device sector.

Table 3. Sectoral Forward and Backward Linkage Effects

No	Industry Classification	ISD (forward linkage effect)	Rank	IPD (backward linkage effect)	Rank
1	Agricultural, forest, and fishery goods	0.8994	21	1.0071	15
2	Mining and quarried goods	0.5942	31	1.0911	11
3	Food, beverages and tobacco products	1.1353	11	1.1606	5
4	Textile and leather products	0.9005	20	1.0412	14
5	Wood and paper products, printing and reproduction of recorded media	0.9875	16	1.1361	7
6	Petroleum and coal products	0.9622	17	0.7479	34
7	Chemical products	1.8303	1	1.0053	16
8	Non-metallic mineral products	0.7521	25	1.1466	6
9	Basic metal products	1.2754	6	0.9965	18
10	Fabricated metal products, except machinery and furniture	1.1526	10	1.1628	4
11	Computing machinery, electronic equipment and optical instruments	1.0750	13	0.8879	25
12	Electrical equipment	1.0092	15	1.0934	10
13	Machinery and equipment	0.8149	23	1.1224	9
14	Transport equipment	1.0627	14	1.2968	2
15	Other manufactured products	0.6341	29	1.1294	8
16	Manufacturing services and repair services of industrial equipment	1.1621	9	0.9842	19
17	Electricity, gas and steam supply	1.1991	8	0.7998	31
18	Water supply, sewage, waste treatment and disposal services	0.7661	24	1.0047	17
19	Construction	0.6533	28	1.0631	13
20	Wholesale and retail trade and commodity brokerage services	1.8046	2	0.9286	24
21	Transportation	1.6743	3	0.9489	22
22	Food services and accommodation	0.9371	18	1.1779	3
23	Communications and broadcasting	1.0994	12	0.8796	26
24	Finance and insurance	1.3029	5	0.8485	28
25	Real estate services	0.9321	19	0.7536	32
26	Professional, scientific, and technical services	1.5914	4	0.9298	23
27	Business support services	1.2447	7	0.8360	29
28	Public administration, defense, and social security services	0.8583	22	0.7517	33
29	Education services	0.5486	34	0.8052	30
30	Health and social care services	0.5783	33	0.8752	27
31	Art, sports, and leisure services	0.6143	30	0.9520	21
32	Other services	0.6750	27	1.0813	12
33	Others	0.5890	32	1.3840	1
34	Home beauty device	0.6840	26	0.9709	20

Table 3 presents the results of analyzing the forward linkage effects (ISD) and backward linkage effects (IPD) of the home beauty device industry with other industries. The forward linkage effect, represented by the ISD, measures the extent to which the sector supplies inputs to other industries and reflects its sensitivity to economic fluctuations [30]. The ISD for the home beauty device industry is relatively low, at 0.6840 and ranked 26th, indicating limited integration as a supplier and reduced sensitivity to economic fluctuations compared to other sectors. This finding aligns with those for related sectors, such as beauty and medical devices, which also demonstrate limited vulnerability to financial disruptions and general economic conditions [17], [31]. For example, [17] reported an ISD of 0.534 for the beauty industry, and [21] found an ISD of 0.657 for the medical and measuring device industry, both below the economy-wide average, similar to the home beauty device industry.

The lower ISD of the home beauty device industry likely arises from its characteristics as a final consumer goods sector with limited use as intermediate inputs in other industries, such as medical facilities. Additionally, the relatively recent emergence and current growth stage of the industry imply that potential spillover effects on other sectors remain limited but have significant scope for future expansion. In contrast, sectors exhibiting high ISD values include “Chemical products (sector 7)” (1.8303), “Wholesale and retail trade and commodity brokerage services (sector 20)” (1.8046), and “Transportation (sector 21)” (1.6743), reflecting their critical roles as intermediate input suppliers within the broader economy.

The backward linkage effect, represented by the IPD, measures the industry’s reliance on inputs from other sectors. The IPD for the home beauty device industry is 0.9709, ranked 20th, reflecting moderate dependency on other industries. This is lower compared to highly interconnected sectors such as “Others (sector 33)” (1.3840), “Transport equipment (sector 21)” (1.2968), and “Food services and accommodation (sector 22)” (1.1779). Previous studies in related fields similarly report higher IPD values compared to ISD values, highlighting a greater dependency on upstream sectors [14], [16, 17]. The relatively higher IPD ranking compared to ISD for the home beauty device industry confirms its status as a manufacturing sector moderately reliant on upstream materials and infrastructure, while its lower ISD and IPD values suggest that it currently occupies a specialized niche within the overall economy.

The graphical representation of the forward and backward linkage effects is illustrated in Figure 1, offering a visual summary of the inter-industry dynamics associated with the home beauty device sector. ISD and IPD values above 1 indicate an above-average economic impact, while values below 1 denote a smaller-than-average economic role [32]. The home beauty device industry (sector 34) has ISD and IPD values of 0.6840 and 0.9709, respectively, placing it within the third quadrant, indicating characteristics of a specialized and independent industry with limited economic interdependencies. Consequently, enhancing inter-industry linkages through technological innovation, research and development collaborations, and strategic local and international partnerships is essential to increase the industry’s economic spillover effects and broaden its impact on the national economy.

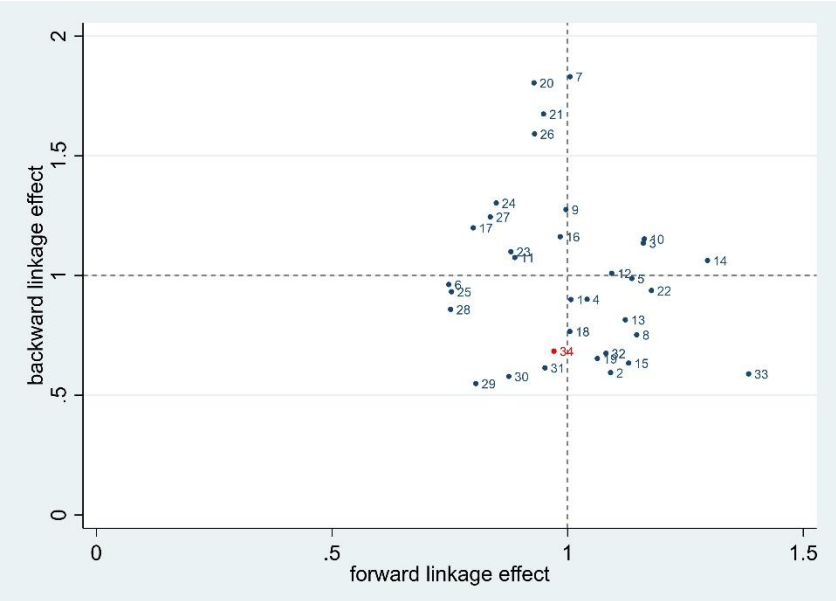

Figure 1. Inter-Industry Linkage Effects of the Home Beauty Device Industry

Overall, these findings affirm that the home beauty device industry significantly contributes to production, value-added creation, and employment generation, despite exhibiting relatively moderate inter-industry linkage effects. The summary results of the home beauty device industry-based IO analysis is presented in Table 4. Based on the analysis results, the domestic market size of 1.6 trillion KRW as of 2022 is estimated to have generated total production of 2.73 trillion KRW, added value of 1.50 trillion KRW, and 8,678 employments, including 7,134 wage workers. As demand and market size are projected to grow continuously, the industry's spillover effects are expected to expand further if competitiveness is sustained.

From a comparative perspective, the production-inducing effect of the industry (1.708) is slightly lower than the national average (1.804) [11]. This suggests that the home beauty device industry has relatively low intermediate input requirements compared to more traditional manufacturing sectors, and reflects Korea's broader industrial structure where heavy manufacturing holds a larger share. This indicates that the industry has less potential for generating indirect demand in upstream industries, therefore policies should be targeted to foster stronger backward linkages to amplify its production spillovers.

Meanwhile, the value-added creation effect of the industry (0.935) is considerably higher than the national average (0.806). This highlights the industry's technology-intensive and high-value-added characteristics, as it represents one of the fastest-commercializing segments of the beauty-tech market. The rapid integration of advanced technologies, such as AI, AR, and metaverse applications, has accelerated personalization and customization, while the bundling of beauty devices with cosmetics generates strong synergies with adjacent industries [3]. Korea could further leverage this advantage by supporting R&D, intellectual property protection, and cross-sector collaboration with ICT and cosmetics to consolidate its global leadership in high-value segments.

On the labor side, both the employment-inducing effect (5.42) and the labor-inducing effect (4.46) are lower than the national averages of 9.7 and 7.2, respectively [33]. However, these values are comparable to the averages observed in the assembly and processing products categories (sector 11-15) of 5.3 and 4.4, respectively. This indicates that the industry is not labor-intensive compared to service or agriculture-related sectors, and it exhibits employment patterns similar to other similar and advanced manufacturing sectors. Thus, the industry's contribution lies less in sheer job numbers and more in generating relatively high value-added positions, particularly for skilled labor associated with R&D, design, and advanced manufacturing processes.

Table 4. Summary Results of the Home Beauty Device Industry Input-Output Analysis

	Production-inducing effect	Value-added creation effect	Employment-inducing effect	Labor-inducing effect
Direct Effect (A)	1.0000	0.5427	2.3445	2.1179
Indirect Effect (B)	0.7078	0.3925	3.0795	2.3410
Total Effect (A+B)	1.7078	0.9352	5.4240	4.4589

Furthermore, a supplementary regional analysis provides insights into the spatial distribution of the industry's performance. Export volumes of the home beauty device industry, identified by HS code 8543.7020, across Korea's 17 metropolitan cities and provinces were examined as a proxy for regional output and performance. Based on the K-stat of Korea International Trade Association (KITA), from 2007 to 2024, Seoul consistently dominated industry exports, with its share rising markedly in the early 2010s and peaking at approximately 120 million USD in 2024, more than half of the national total. Gyeonggi Province has established itself as the second-largest contributor, demonstrating steady growth over the same period and reaching 76.6 million USD in 2024. Combined, Seoul and Gyeonggi account for over 90% of national exports, underscoring the concentration of production and export capacity in the capital region. By contrast, contributions from other provinces remain modest, indicating limited regional diversification and highlighting the industry's reliance on a geographically centralized supply chain and production infrastructure.

In addition to the national and regional findings, a comparison of Korea's export performance with other major exporters under HS 6-digit 8543.70 code of the home beauty device industry provides a useful international perspective. Globally, the market is dominated by China, whose exports exceeded USD 19 billion in 2021 and remained above USD 12 billion in 2024, far surpassing all other countries. The United States follows with stable growth, reaching USD 4.36 billion in 2024, while Japan (approximately USD 2.1 billion)

and Singapore (USD 2.08 billion) also stand out as significant exporters. Several ASEAN economies, including Indonesia, Thailand, and Malaysia, have emerged as strong competitors, in some cases surpassing Korea in recent years. By contrast, Korea's export has remained relatively stable at around USD 1.1-1.3 billion since 2020, representing a modest share of the global market and reflecting a decline from its peak in 2015 (USD 2.76 billion). Specifically, in 2024, Korea ranked 8th globally with exports of approximately USD 1.36 billion (about 3.5% of the top 10 exporters' combined exports). Notably, Korea's export value grew by about 13% compared to the previous year, suggesting ongoing growth potential.

These patterns suggest that while Korea remains a notable player, its global position is increasingly challenged by both established exporters and rapidly advancing regional competitors. Universally, the findings underscore the importance of harmonized product standards, consumer safety regulations, and sustained R&D investment. For Korea specifically, the results point to the need to address geographic over-concentration and to pursue both technological and regional diversification to sustain competitiveness.

Overall, this study highlights the importance of targeted policy interventions to foster innovation, promote cross-sectoral collaboration, and strengthen technological capabilities in related high-tech and service-oriented industries, thereby amplifying the broader economic contributions of the home beauty device industry. Specifically, to stimulate continuous innovation, R&D tax credits and innovation subsidies can reduce financial risks for firms investing in next-generation technologies such as AI-driven personalization, AR/VR-based skin analysis, and IoT-enabled devices [5]. These tools would accelerate the pace of technological upgrading and commercialization. Second, regulatory sandboxes, which are already in use for fintech and digital health in Korea, could be extended to the home beauty device sector [34]. This would allow controlled testing of innovative products in real-market settings while safeguarding consumer trust and ensuring product safety. Finally, because the domestic market is characterized by low entry barriers and a large number of SMEs, targeted support measures are vital. These include preferential access to export financing, government-backed programs for obtaining international certifications, and incentives to encourage sustainable and "clean beauty" production.

5. Conclusions

This study quantitatively analyzed the economic effects of the home beauty device industry in Korea, utilizing the most recent 2020 IO Table. By employing a demand-driven IO model with an externalization approach, the analysis precisely estimated the industry's contributions to production, value-added creation, and employment while distinctly capturing its interactions with other economic sectors.

The findings indicate that an additional 1 KRW of production in the home beauty device industry generates a total production-inducing effect of 1.7078 KRW, encompassing both direct and indirect contributions. Each 1 KRW of production further generates 0.9352 KRW of value-added, while 1 billion KRW in production creates 5.4240 new jobs including 4.4589 wage and salary workers. The industry's development is projected to stimulate production and value-added creation in key sectors such as "Computing machinery, electronic equipment and optical instruments", "Wholesale and retail trade and commodity brokerage services", and "Manufacturing services and repair services of industrial equipment". Additionally, the industry is expected to drive employment growth in "Wholesale and retail trade and commodity brokerage services", "Manufacturing services and repair services of industrial equipment", and "Professional, scientific, and technical services". These findings underscore the home beauty device industry's potential to drive economic growth through its robust linkages with high-value-added and technology-oriented industries.

Despite these substantial economic contributions, the analysis revealed relatively modest inter-industry linkage effects compared to other sectors. The forward linkage effect (ISD = 0.6840), reflecting the industry's role as an intermediate goods supplier, is notably low, indicating limited integration with other sectors and reduced sensitivity to broader economic fluctuations. Similarly, the backward linkage effect (IPD = 0.9709), representing the industry's reliance on upstream inputs, is moderate, suggesting the industry primarily serves a specialized final-use market and occupies a niche position within the broader economic ecosystem.

This study makes several contributions to the literature. First, it provides novel quantitative insights into the significant economic role of the home beauty device industry as an emerging high-value-added sector, highlighting its potential as an important driver of future economic development. Policymakers should consider proactive measures aimed at accelerating industry growth, fostering innovation, and supporting technological advancements. Secondly, strengthening cross-sectoral collaborations, enhancing technological innovation, and facilitating market expansion could significantly amplify the industry's economic spillover effects and improve its inter-industry linkages.

Furthermore, while home beauty devices are currently not regulated under Korea's Medical Device Act, this study provides important insights for policymakers in anticipation of potential regulatory developments or the introduction of new industry standards. For instance, China's GB/T 36419-2018 (Household and Similar Use Skin Beautifying Apparatus) offers a regulatory model that outlines detailed technical requirements, inspection rules, labeling, packaging, transportation, and storage guidelines for household beauty appliances. Finally, for the sustainable growth and enhanced international competitiveness of the Korean home beauty device industry, future policies and strategies should emphasize sustainability considerations throughout the product lifecycle.

While this study provides valuable insights, several limitations highlight directions for future research. First, because the analysis is based on the static 2020 IO table, future work could integrate dynamic analytical frameworks, such as Integrated Assessment Models (IAM) or Computable General Equilibrium (CGE) models, to better capture structural changes and long-term dynamics. In addition, future studies could adopt multi-period IO models that compare estimation results from the 2020 and forthcoming 2025 IO tables, thereby providing deeper insights into the evolving role of the home beauty device industry over time. Finally, while this study establishes a robust national-level baseline, extending the analysis to multi-regional IO (MRIO) or cross-country comparative frameworks would offer a broader perspective by capturing regional spillover effects, urban–rural disparities, and the industry's positioning within global markets and competitiveness.

Conflicts of Interest: The authors declare no conflict of interest.

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Appendix

While the analysis primarily relies on the 2020 benchmark IO table reflecting the 11th KSIC revision, we also conducted a robustness check using the Bank of Korea's extended IO tables for 2021 and 2022. These

annual extension tables apply the 2020 benchmark structure to subsequent years, allowing partial verification of the stability of results. The findings and the rank order of major spillover sectors are consistent across years.

The total production-inducing effect shows a modest decrease (from 1.7078 in 2020 to 1.6774 in 2021 and 1.6479 in 2022), while the value-added creation effect shows a slight increase (from 0.9352 to about 0.9554-0.9562). This suggests that the industry is becoming marginally more value-added intensive relative to its output scale. Employment- and labor-inducing effects also decline slightly over time (from 5.4240 and 4.4589 in 2020 to 4.7790/3.9315 in 2021 and 4.3227/3.5869 in 2022), consistent with trends in advanced manufacturing where technology upgrades reduce labor intensity while boosting value-added. Across all three years, the sectors most affected by home beauty device industry demand remain largely the same: computing/electronic equipment (sector 11), wholesale and retail trade (sector 20), professional/scientific/technical services (sector 26), and business support services (sector 27) consistently rank among the top indirect beneficiaries. The stability of these patterns across three years suggests that the structural characteristics highlighted in the main analysis—high value-added intensity, moderate inter-industry linkages concentrated in advanced services, and relatively low labor intensity compared to traditional manufacturing—are persistent.

Table A1. Home Beauty Device Industry IO Analysis Results using 2021 IO Table

Industry No	Production-inducing effect		Value-added creation effect		Employment-inducing effect		Labor-inducing effect	
	Value	Rank	Value	Rank	Value	Rank	Value	Rank
1	0.0027	25	0.0015	25	0.0495	14	0.0036	30
2	0.0005	33	0.0002	32	0.0012	31	0.0012	31
3	0.0058	21	0.0022	21	0.0129	26	0.0106	24
4	0.0062	20	0.0027	19	0.0167	20	0.0125	22
5	0.0078	17	0.0031	17	0.0229	17	0.0189	16
6	0.0097	16	0.0080	14	0.0008	32	0.0008	32
7	0.0541	4	0.0274	4	0.0688	11	0.0648	10
8	0.0047	23	0.0017	24	0.0114	27	0.0100	25
9	0.0359	8	0.0206	6	0.0250	16	0.0241	14
10	0.0366	7	0.0140	11	0.1038	8	0.0899	7
11	0.1134	1	0.0692	1	0.1138	7	0.1089	6
12	0.0431	6	0.0184	7	0.0744	10	0.0693	9
13	0.0070	18	0.0028	18	0.0163	21	0.0148	18
14	0.0066	19	0.0020	22	0.0100	28	0.0097	27
15	0.0013	30	0.0005	31	0.0066	30	0.0048	29
16	0.0694	3	0.0366	3	0.3746	2	0.3284	2
17	0.0212	11	0.0145	10	0.0132	25	0.0129	21
18	0.0051	22	0.0024	20	0.0273	15	0.0208	15
19	0.0022	26	0.0011	28	0.0136	24	0.0110	23
20	0.0763	2	0.0431	2	0.6160	1	0.3767	1
21	0.0310	9	0.0176	9	0.2532	3	0.1424	5
22	0.0116	14	0.0043	16	0.1154	6	0.0597	11
23	0.0142	13	0.0088	13	0.0541	13	0.0496	12
24	0.0272	10	0.0181	8	0.0880	9	0.0851	8
25	0.0106	15	0.0077	15	0.0212	18	0.0140	19
26	0.0447	5	0.0263	5	0.2500	4	0.2227	3
27	0.0177	12	0.0116	12	0.1827	5	0.1693	4
28	0.0008	32	0.0006	30	0.0069	29	0.0069	28
29	0.0015	29	0.0011	27	0.0161	22	0.0130	20
30	0.0018	27	0.0012	26	0.0185	19	0.0177	17
31	0.0018	28	0.0010	29	0.0156	23	0.0099	26
32	0.0039	24	0.0019	23	0.0608	12	0.0337	13
33	0.0011	31	0.0000	33	0.0000	33	0.0000	33
Sum of indirect effects of other industries (A)	0.6774		0.3723		2.6611		2.0177	

Effect of home beauty device industry (B)	1.0000	0.5831	2.1179	1.9138
Total (A+B)	1.6774	0.9554	4.7790	3.9315

Table A2. Home Beauty Device Industry IO Analysis Results using 2022 IO Table

Industry No	Production-inducing effect		Value-added creation effect		Employment-inducing effect		Labor-inducing effect	
	Value	Rank	Value	Rank	Value	Rank	Value	Rank
1	0.0028	25	0.0014	24	0.0535	13	0.0037	30
2	0.0008	33	0.0003	32	0.0017	31	0.0017	31
3	0.0067	19	0.0026	19	0.0131	24	0.0109	21
4	0.0058	21	0.0027	18	0.0131	23	0.0102	22
5	0.0074	17	0.0030	17	0.0203	16	0.0169	15
6	0.0116	15	0.0096	13	0.0007	32	0.0007	32
7	0.0507	4	0.0255	4	0.0581	12	0.0547	11
8	0.0039	24	0.0014	25	0.0087	27	0.0076	28
9	0.0311	8	0.0184	7	0.0205	15	0.0194	14
10	0.0323	7	0.0122	11	0.0865	8	0.0756	7
11	0.0964	1	0.0596	1	0.0931	7	0.0891	6
12	0.0472	5	0.0213	6	0.0677	10	0.0630	9
13	0.0063	20	0.0025	20	0.0144	21	0.0131	19
14	0.0067	18	0.0019	23	0.0085	29	0.0083	26
15	0.0013	29	0.0005	31	0.0061	30	0.0045	29
16	0.0732	2	0.0370	3	0.3478	2	0.3065	2
17	0.0274	10	0.0183	8	0.0139	22	0.0138	18
18	0.0046	22	0.0021	21	0.0202	17	0.0158	17
19	0.0017	27	0.0008	30	0.0099	26	0.0080	27
20	0.0668	3	0.0378	2	0.5059	1	0.3161	1
21	0.0298	9	0.0176	9	0.2169	4	0.1195	5
22	0.0130	14	0.0050	16	0.1128	6	0.0598	10
23	0.0138	13	0.0083	14	0.0531	14	0.0489	12
24	0.0249	11	0.0163	10	0.0732	9	0.0704	8
25	0.0092	16	0.0065	15	0.0193	18	0.0128	20
26	0.0439	6	0.0254	5	0.2347	3	0.2093	3
27	0.0173	12	0.0111	12	0.1665	5	0.1529	4
28	0.0011	32	0.0008	29	0.0086	28	0.0086	25
29	0.0012	31	0.0008	28	0.0125	25	0.0100	23
30	0.0017	28	0.0011	26	0.0167	19	0.0160	16
31	0.0019	26	0.0011	27	0.0144	20	0.0088	24
32	0.0042	23	0.0020	22	0.0593	11	0.0349	13
33	0.0013	30	0.0000	33	0.0000	33	0.0000	33
Sum of indirect effects of other industries (A)	0.6479		0.3548		2.3516		1.7915	
Effect of home beauty device industry (B)	1.0000		0.6014		1.9711		1.7954	
Total (A+B)	1.6479		0.9562		4.3227		3.5869	