Effects of the forest industry on the South Korean national economy: evidence from an Input-Output analysis based on the special classification for the forest industry

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ABSTRACT
Following the Fourth Industrial Revolution, the forest industry sector now combines cutting-edge technology with other industries. Hence, the Special Classification for the Forest Industry was established to clearly define the scope of the forest industry. Therefore, we reclassify the 2018 input-output table of the Bank of Korea based on the Special Classification of the Forest Industry. Specifically, we calculate the proportion of the forest industry that contributes to the products and services of each industry and divide them into forest and non-forest industry sectors to create the input-output table of the forest industry. We find that a direct and indirect production inducement effect of KRW 193.4 million occurs when KRW 100 million is invested in the forest industry. The import inducement coefficient is 0.221 and the value-added inducement coefficient is 0.779. In the labor sector, the total workers inducement coefficient is 12.9 and the employee inducement coefficient is 8.5.

1. Introduction
1.1. Background
Recently, the needs of consumers have diversified because of technological advancements (e.g. the improved functions of systems and machines, as well as increased connectedness of human beings), while the convergence of industries has also been accelerating and evolving (Susskind and Susskind 2018; Heo and Lee 2019a). The forest industry is also advancing through collaboration with other industries, from traditional timber production and non-timber forest product production/processing to various service areas such as distribution/sales, forest recreation/therapy, and experience/tourism/education. Furthermore, advanced technologies, such as the Internet of Things, robotics engineering, big data, remote sensing, and artificial intelligence, have been applied in the forest industry.
Consequently, the forest industry affects and is affected by many other industries. Similarly, as shown in Figure 1, various other industries are intertwined; thus, changes in a certain industry may affect other industries (Bank of Korea 2014).

The quantitative analysis of the interdependency between these industries is called input-output analysis. In 1936, Leontief expressed the flow of goods and services in the U.S. economy in the form of economics tables and presented the related analysis results. Since then, input-output analysis has evolved rapidly in both theory and application, forming a research axis of applied economics (Leontief 1936; Bank of Korea 2014). Through this analysis, we can determine the changes in output, income, and employment in all industries according to the change in final demand (Miller and Blair 2009).

1.2. Literature Review
In various industries, studies have been conducted to subdivide inter-industry tables. Wolsky (1984) was the first to propose a theoretical model for the aggregation and disaggregation of a sector using input-output analysis. Using Wolsky's methodology, Ferrer and Ayres (2000) subdivided and analyzed input-output tables to examine the effect of the manufacturing sector on the French economy.

Input-output analysis has also been used in South Korea to analyze industries’ economic effects. For instance, Jun et al. (2018) subdivided input-output tables after using the Delphi method and analyzed the effects of the smart port industry. Moreover, input-output analysis has been used to analyze the effects of various industries, such as the fishing industry (Korea Maritime Institute 2014), smart cities (Kim et al. 2016), ubiquitous healthcare services (Kim et al. 2017), the ICT industry (Heo and Lee 2019b), and nuclear power and renewable energy (Kim and Yoo 2021).

Munday and Roberts (2001) assessed the economic contribution of forestry to the rural economy of
Wales. Specifically, they summarized the scale and scope of the forest industry and conducted an input-output analysis using the Welsh input-output tables, augmented by survey data. They showed that increased production in the forest industry, such as that of lumber and pulp, affected the rural economy. In Finland, the intermediate products produced based on the development of forestry may trigger national economic development (Rimmler et al. 2000). Some studies used input-output analyses to determine the effects of the forest industry on the national industry (e.g. Ni Dhubháin et al. 2009; Bösch et al. 2015).

Studies using input-output analysis have also identified the effects of the forest industry on the South Korean economy. For instance, Kim and Baik (1982) used inter-industry tables (as of 1975) to analyze the effect of forest production on the national economy. Subsequently, Park and Kim (1984) conducted an analysis using inter-industry tables. Min (2020) analyzed the positions and contributions of the forestry, wood, and pulp and paper industries to the national economy.

Previous studies used input-output analysis to assess the effects of certain sectors of the forest industry (e.g. Han 2008; Han 2013; Lee et al. 2017), rather than the forest industry as a whole, on the South Korean economy. These studies did not reflect the fact that the forest industry became more diversified as it converged with other industries. Since various products and services are produced to meet consumer needs in the forest industry, it is necessary to analyze the effects of the entire industry.

Further, when preparing forest industry policies or forest management policies, it is important to understand the proportion of the forest industry with respect to the national economy and its relationships with other industries (Min 2020). Roadmaps of the forest industry can be presented based on these relationships.

### 1.3. Purpose of this study

In this study, a subdivision of input and output tables was carried out. While previous studies subdivided input and output tables individually using their own standards and methods, this study subdivided them according to the Special Classification for the Forest Industry (SCFI) approved by Statistics Korea in December 2020. Since this study analyzed the impact of the forest industry on the Korean economy, it used the classification system as a starting point to define the forest industry and set its scope. The specific purpose of this study was to analyze the impact of the forest industry on the national economy, using the SCFI and input-output analysis.

### 2. Methods and materials

#### 2.1. Inter-Industry tables

In the national economy, industries form direct and indirect relationships with each other for the purpose of exchanging products and services for production activities. Inter-industry tables are statistical tables that record inter-industry trading relationships over a certain period (usually one year) in the form of matrices and according to certain principles (Bank of Korea 2014).

Inter-industry tables comprise input-output tables and supply and use tables, which show the production details based on products and industries, respectively. Since input-output tables show the output amount and input structure of each product based on the premise of single product production in each industry, this study used input-output tables, which are more useful than the supply and use tables for ripple effect analysis. Inter-industry tables are a statistic of the system of national accounts (SNA), and the statistics agency of each country publishes them along with the gross domestic product. In South Korea, the first inter-industry tables were produced in 1958, while systematic formats and contents were established for the 1960s inter-industry tables (published in 1964). Benchmark tables are published every five years for inter-industry tables and are updated annually. This study used the 2018 inter-industry tables, published by the Bank of Korea (2020a).

#### 2.2. Input-Output analysis

Input-output tables are statistical tables that record the inputs and outputs of goods and services in each
industry. Based on these factors, we can investigate the effects of external factors or changes in the production and investment in individual industries on the overall economy or other individual industries. They are also used to identify the effects of changes in the final demand or production in a certain sector on production, value-added, employment inducement, and so forth, across the economy (Kim and Yoo 2021). This analytical method is called input-output analysis (Leontief 1936).

2.2.1. Assumptions of Input-Output analysis
An analysis using input-output tables is based on the following four assumptions, considering that the input coefficients are fixed in the input-output analysis: First, there is a 1:1 correspondence between each product and each industrial sector, and no combined production exists. Second, there is no alternative production method, as only one production method exists for each product. Third, economies of scale do not exist and the input used in each sector is proportional to the production level in the sector. Fourth, there is no external economy and the sum of individual production activity results of each sector is the same as the result produced by every sector simultaneously. Based on these assumptions, input-output analysis uses symmetrical input-output tables that can identify the rows and columns on the same basis (Bank of Korea 2014).

2.2.2. Production inducement coefficients
The production inducement coefficient refers to the production amount induced directly and indirectly in each industrial sector for a final demand of one unit (Miller and Blair 2009; Jun et al. 2018).

Assuming that the economy can be classified into n sectors, the input coefficient (a<sub>ij</sub>) and the value-added rate (a<sub>ij</sub>) of each sector can be represented as:

\[
a_{ij} = \frac{x_{ij}}{X_j}, \quad a_{ij} = \frac{v_j}{X_j}, \quad \sum_{i=1}^{n} a_{ij} + a_{jj} = 1 \tag{1}
\]

where a<sub>ij</sub> is the input coefficient of sector j to sector i, x<sub>ij</sub> the input of sector j to sector i, X<sub>j</sub> the total production of sector j, a<sub>ij</sub> the value-added rate of sector j, v<sub>j</sub> the gross value-added of sector j, and n the number of sectors.

Input coefficient matrix A, which arranges the input coefficients in the same shape as the endogenous sectors of the input-output tables, and value-added rate matrix A<sup>v</sup>, can be represented as:

\[
A = \begin{bmatrix}
    a_{11} & a_{12} & \ldots & a_{1j} & \ldots & a_{1n} \\
    \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\
    \vdots & \vdots & \ddots & a_{ij} & \ldots & a_{in} \\
    a_{nj} & a_{n2} & \ldots & a_{nj} & \ldots & a_{nn}
\end{bmatrix},
\]

\[
A^v = \begin{bmatrix}
    a_{11}^v & a_{12}^v & \ldots & a_{1j}^v & \ldots & a_{1n}^v \\
    \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\
    \vdots & \vdots & \ddots & a_{ij}^v & \ldots & a_{in}^v \\
    a_{nj}^v & a_{n2}^v & \ldots & a_{nj}^v & \ldots & a_{nn}^v
\end{bmatrix}
\tag{2}
\]

Because a<sub>ij</sub> · X<sub>ij</sub> = x<sub>ij</sub> in Equation (1), total production X can be expressed as:

\[
\begin{align*}
a_{11}x_{11} + a_{12}x_{12} + \cdots + a_{1j}x_{1j} + \cdots + a_{1n}x_{1n} + y_1 &= x_1 \\
\vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\
\vdots & \vdots & \ddots & a_{ij}x_{ij} + \cdots + a_{in}x_{in} + y_i &= x_i \\
\vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\
\vdots & \vdots & \ddots & a_{nj}x_{nj} + a_{n2}x_{n2} + \cdots + a_{nj}x_{nj} + \cdots + a_{nn}x_{nn} + y_n &= x_n
\end{align*}
\tag{3}
\]

where Y<sub>i</sub> is the final demand of sector i.

Equation (4) shows the process of deriving the production inducement coefficients using Equation (3).

\[
A · X + Y = X, \quad X - A · X = Y, \quad (I - A) · X = Y
\]

\[
\therefore X = (I - A)^{-1} · Y
\tag{4}
\]

where X is the vector of total output, I the unit vector, and Y the vector for the final demand.

In Equation (4), X = (I − A)<sup>−1</sup> · Y means that the final demand (Y) and total production (X) are connected through medium (I − A)<sup>−1</sup>. Here, if the final demand (Y) is given, production (X) is made by the production inducement coefficient ((I − A)<sup>−1</sup>), which is the production system.

Thus, when one unit of the final demand occurs, the production inducement coefficient shows the level of production induced directly and indirectly in each sector to meet the demand. The inverse matrix used in the derivation process is also known as the Leontief inverse matrix (Miller and Blair 2009; Bank of Korea 2014).

Inverse matrix coefficients generated in the process of calculating production inducement coefficients using inter-industry tables show different calculation results depending on the way imported products are handled (Table 1). In general, the following models are used; ‘Type (I − A)<sup>−1</sup>’, ‘Type (I − A + m)<sup>−1</sup>’, ‘Type [I − (I − m)A]<sup>−1</sup>’, and ‘Type (I − A)<sup>−1</sup>’.

In the actual economy, input ratios of domestic and imported products may generally differ from sector to sector. This study separates domestic and imported products to measure the production effect in South Korea based on the final demand for domestic products, but not the final demand for imported products. Equation (5) represents the domestic products:

\[
X = (I - A^d)^{-1} · Y^d \tag{5}
\]

where A<sup>d</sup> is the domestic input coefficient matrix and Y<sup>d</sup> the final demand vector for domestic products.

We use (I − A<sup>d</sup>)<sup>−1</sup>, the production inducement coefficient of Equation (5) for the analysis.

2.2.3. Import Inducement coefficients
The import inducement coefficient refers to the import unit induced directly and indirectly in the national economy when a final demand of one unit occurs for the domestic product of a certain industry.

In A · X + Y = X of Equation (4), the equation for the imported product is given by Equation (6). If X in Equation (6) is substituted into Equation (5), Equation (7) can be obtained:
2.2.4. Value-Added inducement coefficients

Final demand (which comprises consumption, investment, and exports) leads to production, while production activities create added value. The economic effect can be calculated using Equation (9) (Chenery and Watanabe 1958):\

\[ FL_i = \frac{1}{n} \sum_{j=1}^{n} a_{ij} \]  

where \( FL_i \) are the forward linkage effects, \( BL_j \) the backward linkage effects, and \( n \) is the number of sectors.

2.2.6. Labor Inducement coefficients

In economic activity, each industry not only directly inputs labor to produce the final output but also increases the output of other industries by using the products of other industries as intermediate products, which indirectly induces the input of labor in related industries. The labor inducement coefficient is a quantitative expression of the amount of labor directly or indirectly induced in the ripple process between industrial sectors of production (Bank of Korea 2014). Final demand leads to production and labor demand. Therefore, the labor inducement effect can be calculated by determining the relationship between final demand and labor demand (Jun et al. 2018). The labor coefficient \( l \) is calculated by dividing the vector by the number of workers \( L \) by the vector for the total production \( X \) (Equation (10)). The labor inducement coefficients can be expressed by Equations (11,12) using the labor coefficients and production inducement coefficients:

\[ l = L \div X \]  

The forward linkage effects \( FL_i \) can be determined by calculating the index of the sensitivity of dispersion, while the backward linkage effects \( BL_j \) can be determined by calculating the index of the power of dispersion. In general, the forward linkage effects \( FL_i \) increase as the output of a certain industry used as an intermediate product in each industrial sector increases, and the backward linkage effects \( BL_j \) increase as the intermediate products of various industries are used in the output production of a certain industry (Korea Maritime Institute 2011). Forward linkage effects \( FL_i \) and backward linkage effects \( BL_j \) can be calculated using Equation (9) (Chenery and Watanabe 1958):

\[ FL_i = \frac{1}{n} \sum_{j=1}^{n} a_{ij} \]  

where \( FL_i \) are the forward linkage effects, \( BL_j \) the backward linkage effects, and \( n \) is the number of sectors.
Table 2. Spatial and industrial scope of the forest industry in the SCFL.

| Category | Description |
|----------|-------------|
| Spatial scope | Represents the activity spaces of the forest-related industries and includes industrial activities in land spaces other than forests. |
| Industrial scope | Includes industries producing, distributing, and processing forestry products; service industries including lodging, leisure, entertainment, and woodland burial services; and industries that support these industries. |

Table 3. Classification of forestry and forestry-related industries within the KSIC.

| Sector | Division | Groups | Class | Subclass |
|--------|----------|--------|-------|----------|
| A. Agriculture, forestry and fishing | 02. Forestry | 020. Forestry | 0201. Silviculture activities | 02011. Operation of forest tree nurseries |
| | | | 02012. Afforestation |
| | | | 0202. Logging |
| | | | 02020. Logging |
| | | | 0203. Gathering of non-timber forest products |
| | | | 02030. Gathering of non-timber forest products |
| | | | 0204. Support services to forestry |
| | | | 02040. Support services to forestry |

As such, the forest industry includes all sectors related to forests and forestry products, such as the product production sector; product production support sector; product processing, distributing, and selling sectors; and forest-related services sector. However, forest-related industrial sectors also belong to other categories, although sub-categories remained unclassified. Therefore, the exact size of the forest-related industry is difficult to determine.

The structure of the SCFI comprises six sectors in the large category, 33 divisions in the medium category, 55 groups in the small category, and 130 classes in the micro category (Table 4).

2.4. Analytical scheme and data

This study analyzed the impact of the forest industry on the national economy according to the flow chart in Figure 2.

This study used the micro-sized input-output table, which shows the classification in the smallest unit among the input-output tables (based on producer’s price) provided by the Bank of Korea (2020a), to analyze the forest industry. This table divides the South Korean economy into 381 industries.

To apply the forest industry to this input-output table, the sectors corresponding to the SCFI among the categories of the KSIC (Statistics Korea 2017) were linked to the goods and services of the input-output table. Since forest industry sectors and non-forest industry sectors might be mixed, we needed to split them.

Since specific statistics were not available for the share (%) of the forest industry in each industry, this study calculated the share (based on the number of industrial enterprises) based on the results of the “Special Classification for the Forest Industry Industrial Status Basic Survey” and the “2019 Census on Establishments” (Statistics Korea 2021). Based on the calculated share (%), we split the goods and services of the input-output table into forest and non-forest industry sectors using Wolsky’s (1984) method and created the “Forest Industry Input-Output Tables (431 x 431).” There were 69 goods and services (based on the input-output tables) classified as forest industry, which were recategorized into one category of the SCFI. The goods and services classified as non-forest industry were reclassified in the large...
category using the “Classification of Commodities Table” of the Bank of Korea (2019). Subsequently, the South Korean economy was classified into 34 sectors of goods and services (including one forest industry sector), based on which the production inducement coefficients, import inducement coefficients, and value-added inducement coefficients were derived. Furthermore, we used the “Number of Workers and Hours Worked” provided by the Bank of Korea (2020b) and Equations (10–12) to derive the labor inducement coefficients of the SCFI.
In addition, the input and output tables for the Traditional Forest Industry (TFI) were established and then compared with the input and output tables of the SCFI. Thus, we analyzed the influence of the forest industry on the Korean economy to understand the importance of the forest industry and the need for more accurate statistical output. The data used in this study were analyzed using Microsoft Excel (Office 2019) software.

3. Results and discussion

3.1. Production inducement coefficients, import inducement coefficients, and Value-Added inducement coefficients of the Forest industry

We calculated the production inducement coefficients (PIC), import inducement coefficients (IIC), and value-added inducement coefficients (VIC) for each sector in the large category using Equations (5,7,8), respectively, as listed in Table 5.

The calculation indicated the PIC of the Forestry Industry (SCFI) was 1.934, which was the 14th highest industry out of 34 industries in the national economy, and higher than the average of all sectors of 1.861. When a final demand of one unit occurs in this sector, a total production of 1.9340 units is induced directly and indirectly in the national economy. Considering that the total output of the entire Forest Industry (SCFI) was 124.64 trillion KRW in the “2018 Forest Industry Input-Output Table,” this means that approximately 241 trillion KRW of production is directly or indirectly induced in the national economy as a whole.

When an industry produces a unit of product, both the inducement effect on this industry and the inducement effect on other industries occur. The sector with the highest value, excluding the self-induced effect on industrial production in this sector, was “Chemical products (C05),” which generated a value of 0.084, followed by “Wholesale and retail trade and commodity brokerage services (G),” with 0.069, and “Transportation (H),” with 0.065. The products and services produced by these industries are those most utilized by the SCFI. Conversely, other industries using the SCFI’s products and services are described in Section 3.3.

The calculated IIC of the SCFI was 0.221, which was the 15th highest industry in the national economy, but lower than the average of all sectors of 0.237. When a final demand of one unit occurs in this sector, total imports of 0.221 units are induced directly and indirectly in the national economy. The sector with the highest value, excluding the self-induced effects on

| Table 5. Computation of the inducement coefficients by industry, including the forest industry (SCFI). |
|---|---|---|
| Code | Sector | PIC | IIC | VIC |
| A | Agricultural, forest, and fishery goods | 1.8874 | 0.1585 | 0.8415 |
| B | Food, beverages, and tobacco products | 2.1946 | 0.2500 | 0.7500 |
| C01 | Textile and leather products | 1.9220 | 0.4487 | 0.5513 |
| C02 | Printing, and reproduction of recorded media | 2.0190 | 0.1682 | 0.8318 |
| C03 | Petroleum and coal products | 1.2379 | 0.6596 | 0.3404 |
| C04 | Chemical products | 1.8997 | 0.4049 | 0.5951 |
| C05 | Non-metallic mineral products | 2.1454 | 0.2644 | 0.7356 |
| C06 | Basic metal products | 1.8843 | 0.5094 | 0.4906 |
| C07 | Fabricated metal products, except machinery and furniture | 2.1062 | 0.2543 | 0.7457 |
| C08 | Computing machinery, electronic equipment, and optical instruments | 1.5439 | 0.3562 | 0.6438 |
| C09 | Electrical equipment | 2.0459 | 0.3416 | 0.6584 |
| C10 | Machinery and equipment | 2.1143 | 0.3024 | 0.6976 |
| C11 | Transport equipment | 2.4315 | 0.3117 | 0.6822 |
| C12 | Other manufactured products | 2.0686 | 0.3304 | 0.6926 |
| C13 | Manufacturing services and repair services of industrial equipment | 1.9168 | 0.1582 | 0.8418 |
| D | Electricity, gas, and steam supply | 1.5069 | 0.5630 | 0.4370 |
| E | Water supply, sewage and waste treatment and disposal services | 1.7808 | 0.1381 | 0.8619 |
| F | Construction | 2.0032 | 0.1798 | 0.8202 |
| G | Wholesale and retail trade and commodity brokerage services | 1.7485 | 0.1237 | 0.8763 |
| H | Transportation | 1.7725 | 0.3486 | 0.6514 |
| I | Food services and accommodation | 2.1713 | 0.1812 | 0.8188 |
| J | Communications and broadcasting | 1.6648 | 0.1365 | 0.8635 |
| K | Finance and insurance | 1.6317 | 0.0733 | 0.9267 |
| L | Real estate services | 1.4354 | 0.0420 | 0.9580 |
| M | Professional, scientific, and technical services | 1.7941 | 0.1338 | 0.8642 |
| N | Business support services | 1.5129 | 0.0846 | 0.9154 |
| O | Public administration, defense, and social security services | 1.3721 | 0.0776 | 0.9224 |
| P | Education services | 1.4844 | 0.0762 | 0.9238 |
| Q | Health and social care services | 1.7405 | 0.1716 | 0.8284 |
| R | Art, sports, and leisure services | 1.7885 | 0.1222 | 0.8778 |
| S | Other services | 2.0102 | 0.1699 | 0.8301 |
| T | Others | 2.5746 | 0.1485 | 0.8515 |
| SCFI | Forest industry products and services classified as SCFI | 1.9340 | 0.2214 | 0.7786 |
| Average of all sectors | 1.8610 | 0.2365 | 0.7635 |

*Excluding the forest industry.
PIC: production inducement coefficient; IIC: import inducement coefficient; VIC: value-added inducement coefficient
industrial import in this sector, was “Mined and quarried goods (B),” which generated a value of 0.053, followed by “Chemical products (C05),” with 0.026, and “Petroleum and coal products (C04),” with 0.014.

Calculation indicated that the VIC of the SCFI was 0.779, and that it was the 20th highest industry in the national economy, higher than the average of all sectors of 0.764. When a final demand of one unit occurs in this sector, a total value added of 0.779 units is induced directly and indirectly in the national economy. The sector with the highest value, excluding the self-induced effects on industrial value-added in this sector, was “Wholesale and retail trade and commodity brokerage services (G),” which generated a value of 0.037, followed by “Finance and insurance (K),” with 0.033, and “Real estate services (L),” with 0.027.

3.2. Inter-Industry linkage effects between Forest industry and other industries

To determine the relative position of the forest industry in the national economy, we analyzed the index of the sensitivity of dispersion (forward linkage effect) and the index of the power of dispersion (backward linkage effect), as shown in Figure 3.

In Figure 3, the index of the sensitivity of dispersion and the index of the power of dispersion for the sectors in Quadrant I are all higher than 1, the average of all sectors, indicating that the forward and backward linkage effects were all large. Since they can have strong effects on the whole industry and can be significantly affected by external influences, said sectors are classified as key sectors (KS) (Beynon et al. 2009). KSs can accelerate and amplify changes and support and promote other industries, playing a vital role in economic development (Hirschman 1958; Cristóbal 2008). Based on the results of analyzing the linkage effects, the Traditional Forest Industry (TFI) is classified as a WOS with an index of the sensitivity of dispersion of 0.5916 and an index of the power of dispersion of 0.8134, as shown in Figure 3(b). Quadrant IV includes sectors with weak effects on the entire industry but high sensitivity, classified as forward-linked oriented sectors (FLOS) (Beynon et al. 2009; Ministry of Internal affairs and communications 2009).

3.3. Relationships and influences of production between Forest industry and other industries

It is important for policy makers to understand the state of the forward and backward linkages of industries to drive and formulate policies. The forest industry uses products and services from other industries and provides products and services to other industries. To clearly understand to which industries SCFI is connected to, we present a chord diagram in Figure 4.

This chord diagram shows the transaction flow in each industry in two-way directions. In this figure, the PIC matrix calculated in the analysis process was used, and the self-induced effect on industrial production was excluded. We also highlight the relationships and influences between other industries, with focus on SCFI.

The PIC of the SCFI, excluding the self-induced effect on industrial production, was 0.815, which was the 15th highest in all industries. According to the analysis, the SCFI affected the production of other industries in the order “Printing and reproduction of recorded media (C03),” “Non-metallic mineral products (C06),” and “Food, beverages, and tobacco products (C01).” The SCFI’s products and services accounted for 23.8% (C03), 11.0% (C06), and 7.7% (C01) of the production of these industries. SCFI was
observed to have an impact on all industrial production, that is, the national economy.

### 3.4. Labor Inducement coefficients of the Forest industry

We calculated the labor inducement coefficients of all industries and the forest industry (SCFI) using Equations (10–12). The analysis of the employees’ inducement effects of the whole forest industry (SCFI) and other sectors (large category) shows that the total workers inducement coefficient was 12.9, which means that when KRW 1 billion is injected, employment of 12.9 persons is directly or indirectly induced. The total workers inducement coefficient of the forest industry was higher than 11.0, the average of all sectors. The employee inducement coefficient was 8.5, which was higher than 7.6, the average of all sectors.

"Wholesale and retail trade and commodity brokerage services (G)" has both the highest total workers inducement coefficient and highest employee inducement coefficient, excluding the self-induced effects, inducing effects of 0.8 and 0.6, respectively.

### 4. Conclusions

We conducted an input-output analysis using data such as the “Special Classification for the Forest Industry (SCFI)” approved by Statistics Korea and the “2018 Input-Output Tables” of the Bank of Korea to estimate the ripple effect of the forest industry, which has been diversified by technological development and social change. This study differs from previous studies in that the current approach analyzed the entire forest industry using the SCFI, a classification system that expanded and subdivided the scope of the forest industry.

There are three main findings of this study: (1) As a result of using input-output analysis, the PIC of the forestry industry (SCFI) was calculated as 1.9340, the IIC was 0.2214, and the VIC was 0.7786 (Table 5). (2) As a result of analyzing inter-industry linkage effects for the forest industry (SCFI) classified as SCFI and TFI classified as KSIC, the TFI was classified as WOS because both $BL_j$ and $FL_i$ were lower than the average of the entire industry. In contrast, SCFI was classified as KS, which can support and promote other industries, as both $BL_j$ and $FL_i$ were higher than the average of the entire industry (Figure 3). (3) As a result of analyzing the labor inducement coefficients of the SCFI, the total workers inducement coefficient was calculated as 12.9 and the employee inducement coefficient as 8.5 (Section Labor Inducement coefficients of the Forest industry). These results show that the forest industry has a significant impact on the Korean economy.

In addition, all industries in the national economy were interrelated in production activities and, exerted influence and were influenced (Figure 4). As the forest industry has a close relationship with other industries, it is necessary to consider the forest industry and its economic ripple effects when developing policy.
There are three conclusions to be drawn from this study. First, the PIC of the forest industry was higher than the average of all industries (1.8610), and as a result of the inter-industry linkage effects analysis, the forest industry was classified as a key sector (KS). This means that the forest industry is an important industry in the Korean economy, and policies to maintain or enhance this status are necessary.

Second, the timber-related industries, which are TFIs, are also important industries, but it is necessary to establish policies centered on the expanded forest industries. The economic ripple effect of the forest industry will be further increased by providing support for the forest industry, wholesale and retail, transportation, education, research, and entertainment, as well as raw material production and processing industries.

Third, the SCFI’s total workers inducement coefficient and employee inducement coefficients were both higher than the average of all industries. This indicates that when a certain amount of money is invested in the forest industry, it creates more labor than does similar investment in other industries. However, on the contrary, it also indicates that this industry is sensitive to external shocks to the creation of labor. In the rapidly changing industrial environment, cutting-edge technologies, such as automation and ICT, should be preemptively grafted into the forest industry to create new jobs.

This study had some limitations. For instance, when calculating the ratio of the forest industry to each industry, there was no statistical data to determine the size and sales revenue of all companies, so we had to calculate them based on the number of enterprises in each industry. However, the SCFI will enable future studies to analyze the forest industry and the economy in greater detail. Therefore, the collection of statistical data on the forest industry should be conducted by future studies.

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Notes
1. The Bank of Korea provides input-output tables by separating the domestic transaction tables and the import transaction tables.
2. Employees are wage workers, and for total workers, self-employed and unpaid family workers are added to the wage workers.
3. Statistics Korea has divided (classified) the agricultural and livestock food industry and the forest industry, while maintaining the basic classification structure, considering the usability in the national official statistics and policy domain.
4. The National Institute of Forest Science conducted a survey of the fitness of the population to examine the degree to which the forest industry was related to the Special Classification for Forest Industry. A telephone survey was conducted targeting the industrial enterprises in the Census of Establishments of the Statistics Korea to investigate whether they were engaging in forest-related businesses.
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