Transformation of Vietnam's Industrial Structure and Growth

By

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Abstract

Currently, Vietnam is closely watched for its economic growth and industrial development. The research team has recognized the significance of this issue and conducted a study with the objective of analyzing the details of the economic structure and identifying industries with high growth potential in Vietnam. This research utilizes data from the Input-Output Table constructed by the OECD. The analysis consists of three parts as follows.

In the first part, Network Analysis is performed using the Gephi program, which produces network graphs and connectivity indices among sectors in the economy based on data from the Input-Output Table. The results show a significant transformation in Vietnam's industrial structure from 1996 to 2018. Heavy industries such as petroleum, chemicals, and primary steel, as well as the wholesale and retail sectors, have become major industries driving Vietnam's economy, replacing light industries like paper, non-metallic minerals, and general manufacturing.

In the second part, when considering the industries that have become vital to Vietnam's economy in 2018, along with Backward and Forward Multipliers, it is evident that these industries have the highest increase in both Backward and Forward Multipliers. While these industries may not be Vietnam's main export industries, the results from both analytical methods clearly indicate their role as foundational industries that produce essential goods and form the backbone of the country. Furthermore, the analysis reveals that other industries in Vietnam have higher Backward Multipliers, primarily (with minor changes in Forward Multipliers), indicating their ability to transform into producers of intermediate and exportable goods. Examples include steel processing, computers, and electronics.

In the third part of the analysis, the proportion of intermediate inputs to production costs in Vietnam's industries is studied. The results align with the second part, showing that the majority of industries, especially those involved in exports, have higher proportions of intermediate inputs. This highlights the increasing complexity of domestic supply chains and inter-industry linkages from downstream to upstream sectors.

The findings from this analysis are beneficial for understanding the structure and key drivers of Vietnam's economic growth. The government of Vietnam can use this information to formulate trade and tax policies that align with various industry groups. It is also valuable for Thai private sector entities when selecting

target groups for investment expansion in Vietnam. Additionally, the Thai government can use this analysis to monitor the economic situation in the CLMV subregion in the future.

1. Introduction

1.1 Background and Significance

Vietnam, a country that was once classified as a low-income nation, has undergone significant economic reform and growth since 1986. Subsequently, it has continuously expanded and transitioned from a low-income country to one with middle-income status. Currently, Vietnam has emerged as one of Asia's fastest-growing economies. The overall development of Vietnam can be summarized through the following changes:

1. Economic development has led to a continuous increase in the average income per capita (GDP per capita) of the Vietnamese population. In 2000, the average income per year for the Vietnamese population was approximately $957 USD. However, by 2020, this figure had risen to around $2,655 USD (or approximately 82,000 Thai Baht, using the exchange rate in March 2021) (World Development Indicators - World Bank, 2022).
2. The number of people living below the poverty line has rapidly decreased from 20.7% in 2011 to 6.7% in 2018 (World Development Indicators - World Bank, 2022).
3. Vietnam's economic structure has shifted away from reliance on agriculture towards expansion in the industrial and service sectors, as illustrated in Figure 1. This figure shows the proportions of each sector contributing to Vietnam's GDP growth from 2005 to 2020.

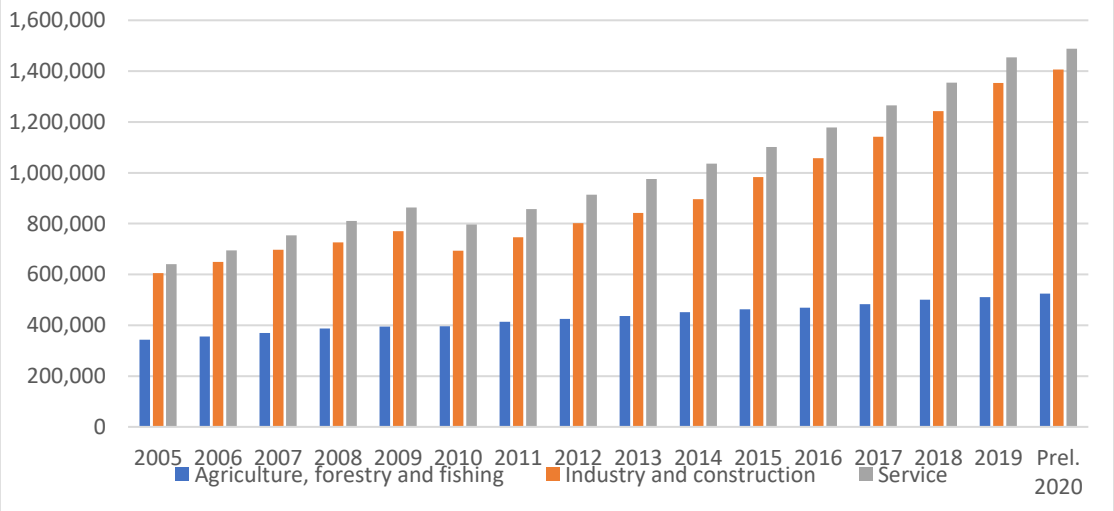

Figure 1: Economic Structure of Vietnam (B.E. 2005-2020) by Major Sectors (Unit: Billion Constant 2010 U.S. Dollars)

Source: General Statistics Office (GSO) of Vietnam (https://www.gso.gov.vn/en) and calculations by researchers.

On December 27, 2020, Bloomberg reported that Vietnam's National Statistics Office disclosed fourth-quarter GDP figures, indicating that Vietnam's GDP had grown by 4.48% compared to the same period in the previous year. This exceeded the expected average growth rate of 4%. Notably, Vietnam's exports increased by 17.6%, and imports rose by 22.7% in December of that year. When calculated for the entire year, Vietnam's exports increased by 6.5%, and imports rose by 3.6%, resulting in a trade surplus valued at 19,060 million U.S. dollars or approximately 573,000 million Thai Baht in 2020.

When considering the entire year of 2020, Vietnam's GDP growth rate was estimated at 2.91%, surpassing the expected rate of 2.8%. However, this growth rate was the lowest in 34 years, compared to the previous annual growth rate of 6-7%. Despite the challenges posed by the COVID-19 pandemic, Vietnam's economy demonstrated resilience and continued growth, largely due to effective control measures and responses to the pandemic. This allowed various sectors of the economy to continue operating.

Given Vietnam's consistent economic growth, the researchers recognize key factors influencing its economic development, specifically the continuous expansion of the country's domestic industries, which have been driving exports. Therefore, this study aims to examine Vietnam's economic growth by utilizing Network Analysis (Centrality Index) and Backward-Forward Multiplier analysis methods to study the structure of Vietnam's economy and industries, emphasizing the changes and major production sectors in Vietnam's economic structure.

1.2Scope of Study

(1) This study focuses on the analysis of industries with high growth potential in Vietnam. It utilizes statistical data from various sources along with quantitative analysis tools to explain the study's findings.

(2) Researchers conducted data retrieval and applied statistical data from Input-Output Tables of Vietnam in the years 1996 and 2018, obtained from the website of the Organization for Economic Cooperation and Development (OECD). The study also employs Network Analysis (Centrality Index) and Backward-Forward Multiplier analysis methods.

(3) The results of this study provide fundamental knowledge and serve as guidelines for further in-depth analysis and policy recommendations related to the subject matter.

2. Literature review

The economy of Vietnam has experienced continuous growth over the past 34 years. The GDP has been able to expand at an average rate of 6.7% per year. This transformation can be attributed to the economic restructuring policies of Doi Moi, implemented in 1986, which increased the role of the private sector and shifted the economy more towards market mechanisms (Tanawat & Natchaphon, 2020).

This economic development has focused on promoting the growth of the private sector, resulting in subsequent growth in foreign trade and investment in Vietnam since 1985 (Poole et al., 2017). The increased foreign investment in Vietnam has led to higher levels of exports and imports, as observed in various studies related to the Vietnamese economy, such as the research by ADB (Poole et al., 2017). Vietnam has become a highly open and trade-friendly country in Asia, participating in various economic groups like the Association of Southeast Asian Nations (ASEAN), Asia-Pacific Economic Cooperation (APEC), the US-Vietnam bilateral trade agreement (BTA), and the World Trade Organization (WTO). The continuous liberalization of trade in Vietnam has been extensively analyzed by McCaig (2011) and McCaig & Pavcnik (2013), who identified it as a crucial factor in changing the economic structure and expanding exports.

Furthermore, in the research conducted by Tanawat and Natchaphon (2020), it was revealed that Vietnam's export market structure is concentrated in five countries: the United States, China, Europe, Japan, and South Korea. These countries accounted for 67% of the total export value in the year 2019 (compared to 58% in 2012). Notably, the major exports that drove this concentration included (1) electronics, particularly mobile phones; (2) textiles; and (3) footwear, accounting for 42%, 11%, and 8% of the total export value in 2019, respectively. This observation aligns with the concept of the "Smiling Curve," which signifies changes that have led to lower value-added activities in the midstream of industries and higher value-added activities at both the upstream and downstream ends of production. Vietnam's participation in international production networks has contributed to these structural changes in its industry. These changes can be analyzed using Input-Output Tables, as demonstrated in Nattapong's research (2020).

Moreover, many countries in Asia have also joined international production networks, resulting in similar structural changes. Relevant research in this area includes studies by Yamano & Ahmad (2006), Meng et al. (2013), Tukker & Dietzenbacher (2013), UNCTAD (2013), and the World Bank (2017). In the case of Thailand, research by Puttanapong (2016) and Sessomboon (2016) has explored similar themes. Additionally, Input-Output Tables can be analyzed in

conjunction with Network Analysis methods, as seen in the works of Cerina et al. (2015), Barabási (2016), and Choi & Foerster (2017). These methods allow for the creation of diagrams that illustrate the connections between different sectors within the economic structure and rank important branches of production.

The analysis by Tanachat (2022) discusses trends in the case study of Thailand. It suggests that entering the era of Industry 4.0 and emerging technologies such as artificial intelligence, robotics, and the Internet of Things (IoT) will lead to changes in production patterns and industry structures, potentially preventing Thailand from generating significantly higher added value in the future. Therefore, studying the structure and key factors of economic growth in Vietnam presented in this research is essential for exchanging perspectives, comparing growth trends, and formulating policy recommendations for Thailand's future.

3. Research Methodology and Data

Given the objectives of this study, which focus on studying the details of the economic structure, the analysis primarily relies on data retrieval and statistical analysis methods. Data from the Input-Output Tables for the years 1996 (B.E. 2539) and 2018 (B.E. 2561) were collected from the Organization for Economic Co-operation and Development (OECD) website. Additionally, economic data from various government agencies in Vietnam, such as the General Statistics Office of Vietnam, and data from the World Development Indicators of the World Bank, were utilized.

3.1) Economic Structure Data for Vietnam

Vietnam's economic expansion has been continuous, as depicted in Figure 2. The GDP growth rate for Vietnam has consistently increased over time (as seen in Figure 2) and has maintained a high growth rate since the economic reform policy known as "Doi Moi" in the year 1985. This growth trend has been sustained to the present day.

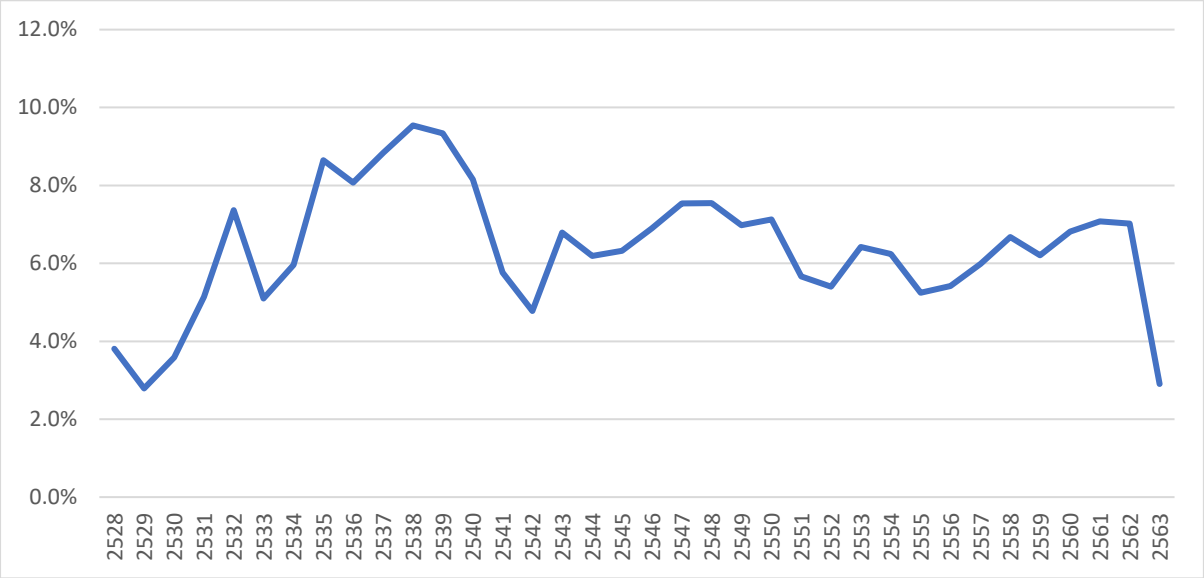

Figure 2: GDP Growth Rates of Vietnam 1985-2020 (B.E. 2528-2563) (Calculated from GDP constant 2015 US$)

Source: World Development Indicators - World Bank, 2022, and calculated by the researchers.

It should be noted that in B.E. 2563 (2020), there was the lowest growth rate since B.E. 2529 (1986). In the second quarter of that year, a high level of COVID-19 infections occurred. Vietnam experienced a GDP growth rate of only 0.36% during that quarter. However, this growth rate was still considered positive, especially when compared to many other countries around the world that saw negative impacts due to COVID-19.

The spread of COVID-19 did impact various sectors within Vietnam's economy. However, the overall economy was not significantly affected compared to other countries, largely due to the effective disease control measures. Details of sector-specific outcomes are presented in Figure 3, which illustrates the potential for expansion. The industrial sector, as a whole, expanded by 1.38% compared to the same period in the previous year. The agricultural sector also expanded by 1.72%. However, the service sector contracted by 1.76%. When examining specific service industries, it's evident that some main branches, such as retail and wholesale trade, increased by 4.3%, and the finance and banking sector increased by 6.78%. Furthermore, data from reports by Vietnamese government agencies also indicate an increase in private sector investment, state investment, and the export of certain goods via waterways (GSO, 2020).

Under the global economic downturn, it is found that Vietnam continues to be minimally affected. According to the GSO report (2020), during the first half of the year 2020, exports decreased by 1.1% compared to the same period the previous year, while imports decreased by 3%. As a result, Vietnam still

maintains a trade surplus of $4 billion with the United States during that period. Although exports have slowed down, major export industries such as mobile phone component manufacturing, which decreased by 8.4%, while other main industrial sectors have shown the potential for expansion. For example, the electronic component manufacturing industry increased by 24.2%, and the machinery and equipment manufacturing industry increased by 25.2%.

These findings from section 3.1 have led to a more detailed examination of production branches and their interconnections within Vietnam's economy, using the data and analytical methods presented in the following sections.

3.2) Input-Output Table Data for Vietnam

Based on the data presented earlier regarding changes in the economic structure and industries of Vietnam, it has been demonstrated that there is economic growth potential and an ability to adapt to changes in the economic structure effectively. In this section, we will conduct an analysis using the Input-Output Table data of Vietnam. The Input-Output Table is a chart that illustrates the flow of goods and services between production sectors of the economy over the course of one year. In this study, we utilize the Input-Output Table data for Vietnam, which was compiled by the Organization for Economic Co-operation and Development (OECD).

This data will be instrumental in understanding the economic structure of Vietnam through the analysis methods of Network Analysis and Backward-Forward Multiplier, as presented in the following sections

- Input-Output Table for Vietnam in the year 1996
- Input-Output Table for Vietnam in the year 2018

The Input-Output Table data comprises details of 44 production sectors (accessible at https://www.oecd.org/sti/ind/input-outputtables.htm). This information will facilitate an understanding of Vietnam's economic structure through the analysis methods of Network Analysis and Backward-Forward Multiplier, as presented in the following sections.

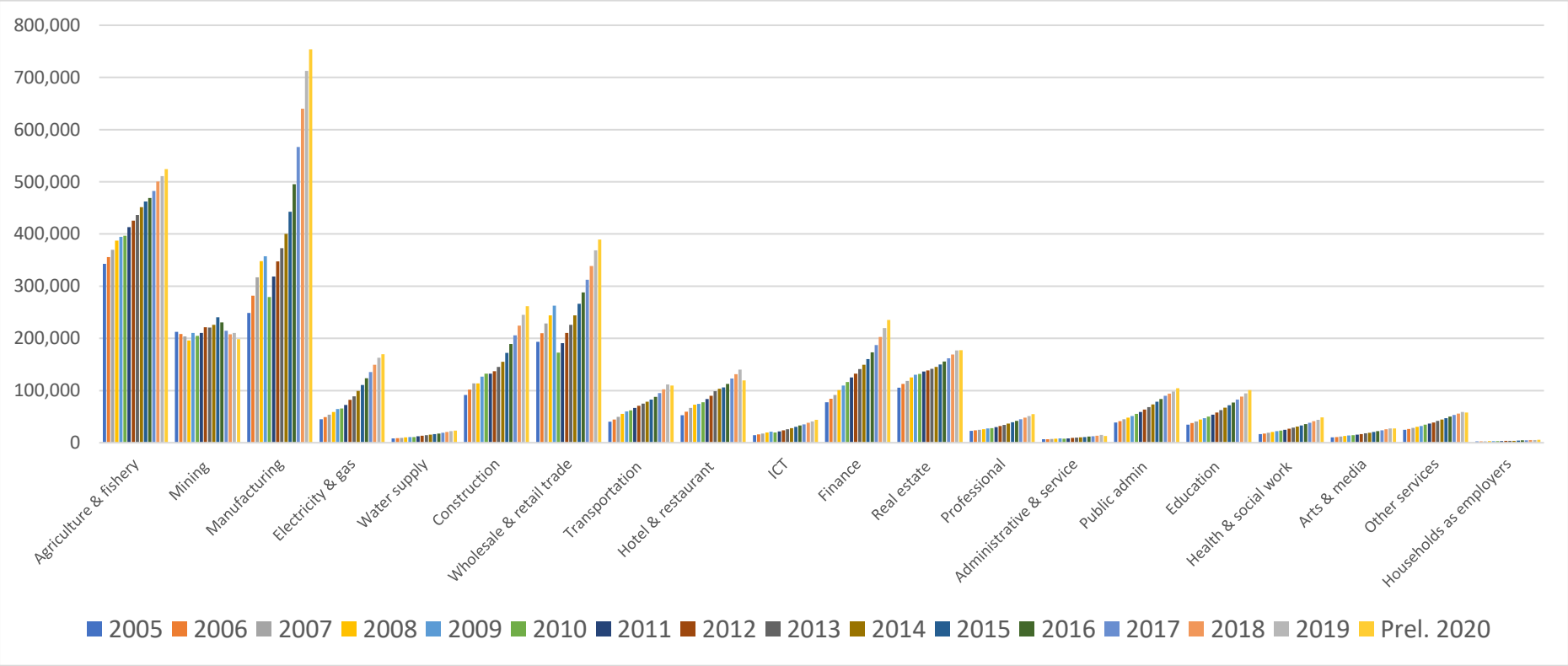

Figure 3: Gross Domestic Product (GDP) by sector in Vietnam (AD 2005-2020) (calculated at constant 2010 prices)

Source: General Statistics Office (GSO) of Vietnam (https://www.gso.gov.vn/en) and researcher's calculations

3.3) Analysis using Forward and Backward Multiplier

The analysis of economic structure linkages can be conducted using data from the Input-Output Table. The details of the calculations, as demonstrated in Miller & Blair (2009) and Nattapong (2020), show that the data presented in each row of the table can be separated into equations as illustrated in equations (1), (2), and (3). These equations represent the relationships of the total output of sector n, which is the total value equal to the left-hand side (X_n) The right-hand side of the equations $X_{n,m}$ s then used as intermediate inputs by other sectors (n, m) in proportions represented by intermediate usage coefficients $a_{n,m}$ Furthermore, these outputs are utilized in final consumption (f_n) (where sectors n and m have a maximum number of branches as per the number of branches in the Input-Output Table).

$$X_1 = a_{11}X_1 + a_{12}X_2 + \cdots + a_{1n}X_n + f_1 \quad (1)$$

$$X_2 = a_{21}X_1 + a_{22}X_2 + \cdots + a_{2n}X_n + f_2 \quad (2)$$

$$X_n = a_{n1}X_1 + a_{n2}X_2 + \cdots + a_{nn}X_3 + f_n \quad (3)$$

The equations presented above can be organized in matrix form as follows:

$$A = \begin{bmatrix} a_{11} & \cdots & a_{13} \\ \vdots & \vdots & \vdots \\ a_{n1} & \cdots & a_{nn} \end{bmatrix},\ X = \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_n \end{bmatrix},\ F = \begin{bmatrix} f_1 \\ f_2 \\ \vdots \\ f_n \end{bmatrix}$$

When you organize the relationships of all three matrices, you will obtain the equation set (3).

$$X = AX + F \quad (3)$$

When you rearrange the equation sides to represent the relationship between F and X, you will obtain the result as shown in equation (4).

$$X = (I - A)^{-1}F = BF \quad ; \quad B = (I - A)^{-1} \quad (4)$$

The value of matrix B represents the Leontief multiplier. The Backward multiplier (BW) for sector j can be calculated as $BW_j = \sum_i b_{ij}$ and the Forward multiplier (FW) for sector i can be calculated as $FW_i = \sum_j b_{ij}$. The Backward multiplier (which reflects the impact on the source sector) indicates the linkage between the mentioned production sector and other sectors that provide raw materials or inputs. On the other hand, the Forward multiplier (which reflects the

impact on the downstream sector, including consumers) indicates the linkage between the mentioned sector and the sectors that use its outputs.

Higher values of both BW and FW indicate stronger linkages with other production sectors, often involving complex production processes and interdependencies. When a sector experiences an expansion in production, it can have a significant impact on upstream sectors (in the case of a high BW) or downstream sectors (in the case of a high FW).

4. Result discussion

4.1) Results of Network Analysis for Each Industry in Vietnam

In this section, we will present the results of the network analysis for various industries in Vietnam's economy. For the initial analysis, we employed the Network Analysis methodology, which generates a graphical representation of the interconnections between sectors within the economic system using data from Input-Output Tables. Additionally, we calculated the Centrality Index to rank the importance of each production sector in the overall economy. In this study, we conducted the analysis using the Gephi software to create network graphs depicting interconnections among production sectors and to compute the Weighted Degree Centrality Index. This analysis aimed to explore changes in the economic structure and industries in Vietnam by comparing data from the years 1996 and 2018.

Following the Network Analysis methodology presented by Cerina and colleagues (2015), Barabási (2016), and Choi & Foerster (2017), we obtained results in the form of network graphs shown in Figure 4 and index values displayed in Figure 5 and Table 1. The Weighted Degree Centrality Index indicates the number of connections of each production sector with other sectors, adjusted for the weighted value of transactions related to each connection. The size of the nodes represents production sectors, and the edges depict the connections in Figure 4. Notably, the sizes of the nodes in Figure 4 correspond to their Weighted Degree Centrality Index values.

It is evident that the interrelationships among industries in Vietnam have strengthened from 1996 to 2018. In 1996., Vietnam's economic structure was primarily composed of the Paper products and printing, Other non-metallic mineral products, and Manufacturing industries, which were the core industries of production and interconnections within the economy. However, in 2018., the structure of Vietnam's economy underwent significant changes. The key

industries included Coke and refined petroleum products, Chemical and chemical products, Basic metals, and Wholesale and retail trade. Notably, the petroleum industry became a major component of the economic system, with numerous connections to other industries related to energy and retail and wholesale trade. Furthermore, there were notable changes in the agricultural industry, which saw increased connections compared to 1996.

The aforementioned results align with the details shown in Figure 5, illustrating changes in the Weighted Degree Centrality Index. In 1996 , industries with high values of this index stood out, including the Paper products and printing, non-metallic mineral products, and Manufacturing industries. Conversely, in 2018, industries with high values of this index were prominently comprised of Coke and refined petroleum products, Chemical and chemical products, Basic metals, and Wholesale and retail trade. Since this index can explain centrality and importance, it is evident that the petroleum, chemical, and basic metals industries became the most significant industries in Vietnam's economy in 2018. This reflects their crucial role as primary raw material producers, which is essential for other industries. Furthermore, the retail and wholesale trade sector also exhibited high values, indicating its vital role in the late years.

Year 1996

Year 2018

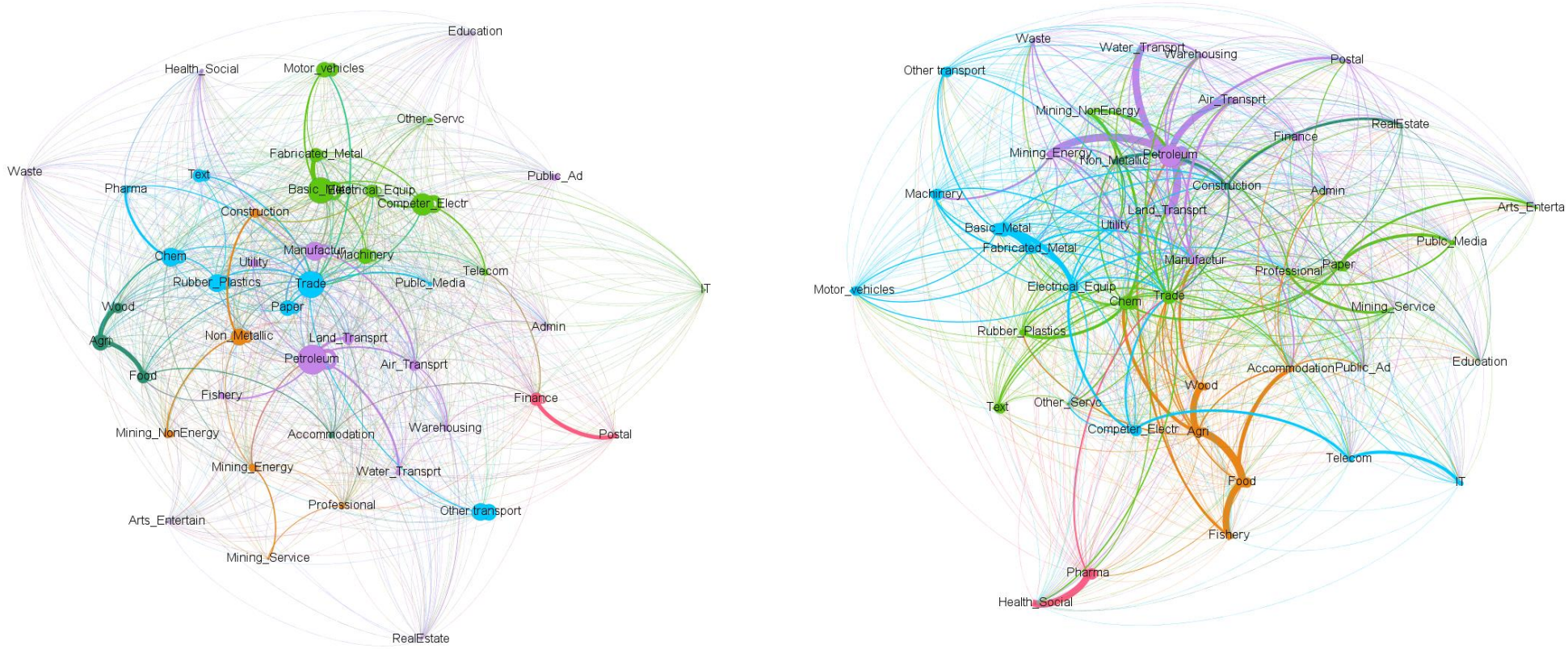

Figure 4: A comparison of network relationship diagrams among industries in Vietnam in the year 1996 and 2018

Source: Statistics data from the OECD - Vietnam Input-Output Tables (IOTs) and calculations conducted by researchers using the Gephi software.

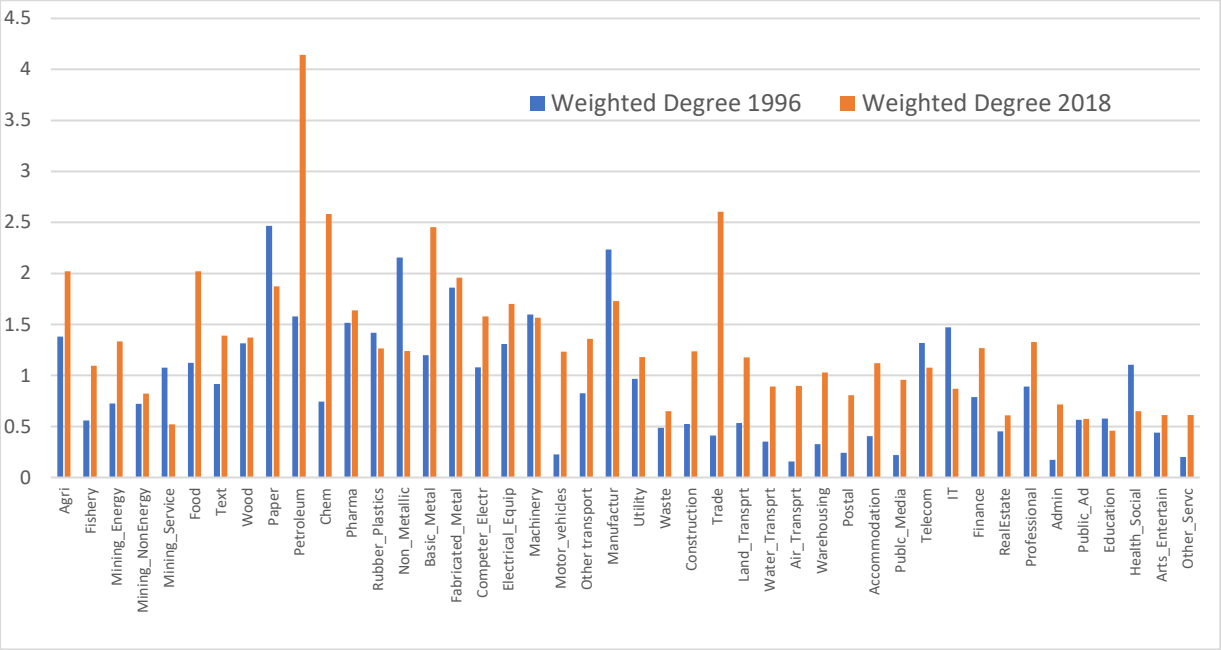

Figure 5: Changes in the Weighted Degree Centrality Index in the years 1996 and 2018

Source: Statistical data from the OECD Vietnam Input-Output Tables (IOTs) and calculations conducted by researchers.

Table 1: A table displaying the Weighted Degree Centrality Index values for each industry in Vietnam in the years 1996 and 2018

	2018	1996		2018	1996
Agriculture, hunting, forestry	1.382	2.021	Electricity, gas, steam and air conditioning supply	0.965	1.181
Fishing and aquaculture	0.558	1.096	Water supply; sewerage, waste management and remediation activities	0.486	0.649
Mining and quarrying, energy producing products	0.726	1.333	Construction	0.524	1.238
Mining and quarrying, non-energy producing products	0.722	0.821	Wholesale and retail trade; repair of motor vehicles	0.410	2.605
Mining support service activities	1.076	0.522	Land transport and transport via pipelines	0.534	1.176
Food products, beverages and tobacco	1.125	2.020	Water transport	0.352	0.891
Textiles, textile products, leather and footwear	0.915	1.390	Air transport	0.156	0.899
Wood and products of wood and cork	1.314	1.371	Warehousing and support activities for transportation	0.327	1.029
Paper products and printing	2.466	1.873	Postal and courier activities	0.241	0.807
Coke and refined petroleum products	1.579	4.141	Accommodation and food service activities	0.405	1.121
Chemical and chemical products	0.745	2.582	Publishing, audiovisual and broadcasting activities	0.221	0.959
Pharmaceuticals, medicinal chemical and botanical products	1.516	1.639	Telecommunications	1.317	1.075
Rubber and plastics products	1.417	1.264	IT and other information services	1.471	0.868
Other non-metallic mineral products	2.156	1.240	Financial and insurance activities	0.787	1.268
Basic metals	1.200	2.456	Real estate activities	0.454	0.608
Fabricated metal products	1.862	1.958	Professional, scientific and technical activities	0.891	1.328
Computer, electronic and optical equipment	1.081	1.579	Administrative and support services	0.173	0.715
Electrical equipment	1.309	1.700	Public administration and defence; compulsory social security	0.564	0.574
Machinery and equipment, nec	1.598	1.565	Education	0.579	0.457
Motor vehicles, trailers and semi-trailers	0.228	1.235	Human health and social work activities	1.104	0.650
Other transport equipment	0.827	1.358	Arts, entertainment and recreation	0.440	0.612
Manufacturing nec; repair and installation of machinery and equipment	2.235	1.729	Other service activities	0.201	0.612

Source: Statistical data from the OECD Vietnam Input-Output Tables (IOTs) and calculations conducted by researchers.

4.2) Study of Backward and Forward Multiplier

The calculation method, as presented in section 3.3, involves analyzing industries as upstream and downstream. It categorizes industries as follows: Industries with a low Backward Multiplier (or an index that reflects the impact on the upstream) and a high Forward Multiplier (or an index that reflects the impact on the downstream) imply that the industry or production sector has a more significant impact on the downstream. This indicates that the production activity serves as the initial stage of the production chain, such as raw material production or basic processing (or an upstream industry). Conversely, if it is an industry located downstream or at the end of the production chain, it will have a high Backward Multiplier but a low Forward Multiplier. In cases where the Backward-Forward Multipliers are similar, it signifies that the industry is intermediate.

From Figure 6 and Table 2, when comparing the changes in the Forward Multiplier values in various industries in Vietnam between the years 1996 and 2018, it is evident that industries with a significant increase in Forward Multiplier values are Coke and refined petroleum products, Chemicals and chemical products, Basic metals, and Retail trade. An increase in the Forward Multiplier value suggests the size of the impact and the connection of these industries to production branches in downstream industries. It reflects the substantial role of these industries as upstream and highlights their clear role in Vietnam's economy. Although these industries may not be the primary exporters of Vietnam, they are considered fundamental industries and a core structure of the country.

Moreover, Figure 7 and Table 3 compare the changes in Backward Multiplier values in various industries in Vietnam between the years 1996 and 2018. It is observed that most industries experienced an increase in Backward Multiplier values. This suggests that Vietnam has been able to shift towards becoming a more significant producer of downstream or export-oriented industries. Key export-oriented industries in Vietnam, such as Computer, electronic and optical equipment, Electrical equipment, Machinery and equipment, Motor vehicles, trailers, and semi-trailers, and transport equipment, have seen an increase in Backward Multiplier values compared to 1996. This reflects the ability to expand the production process within the country, particularly in the upstream and midstream of long and complex production chains, thus stimulating related industries to increase production. Consequently, this has led to overall economic expansion.

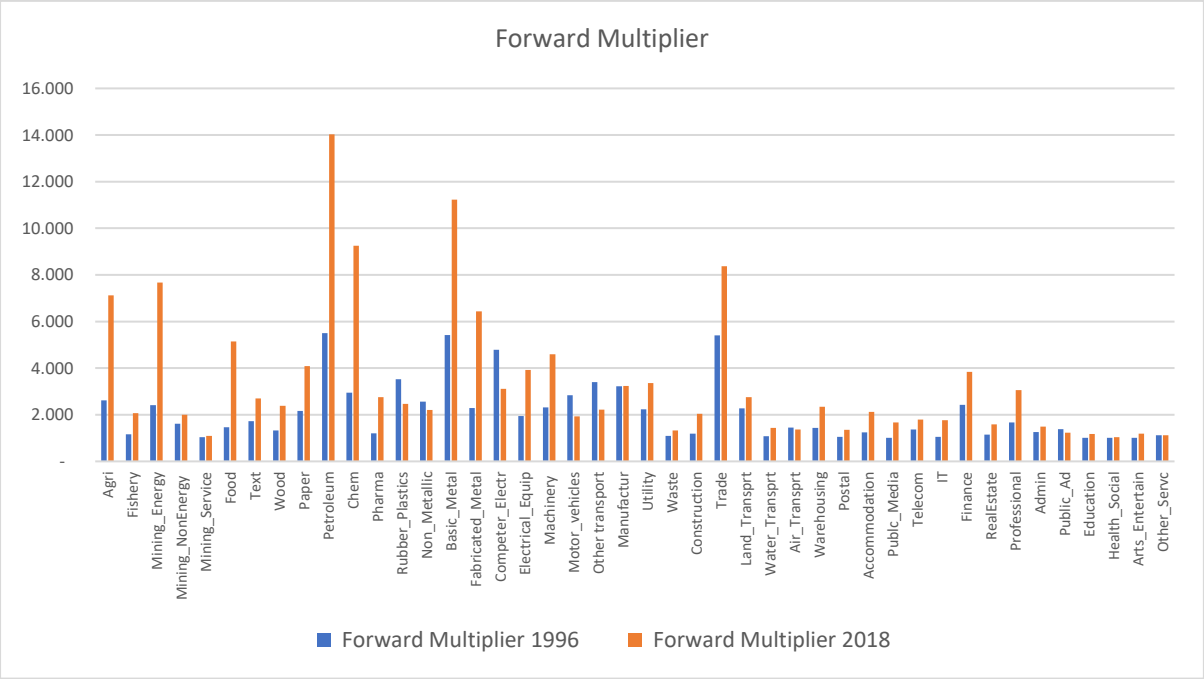

Figure 6: Changes in Forward Multiplier in the years 1996 and 2018

Source: Statistical data from the OECD Vietnam Input-Output Tables (IOTs) and calculations conducted by researchers.

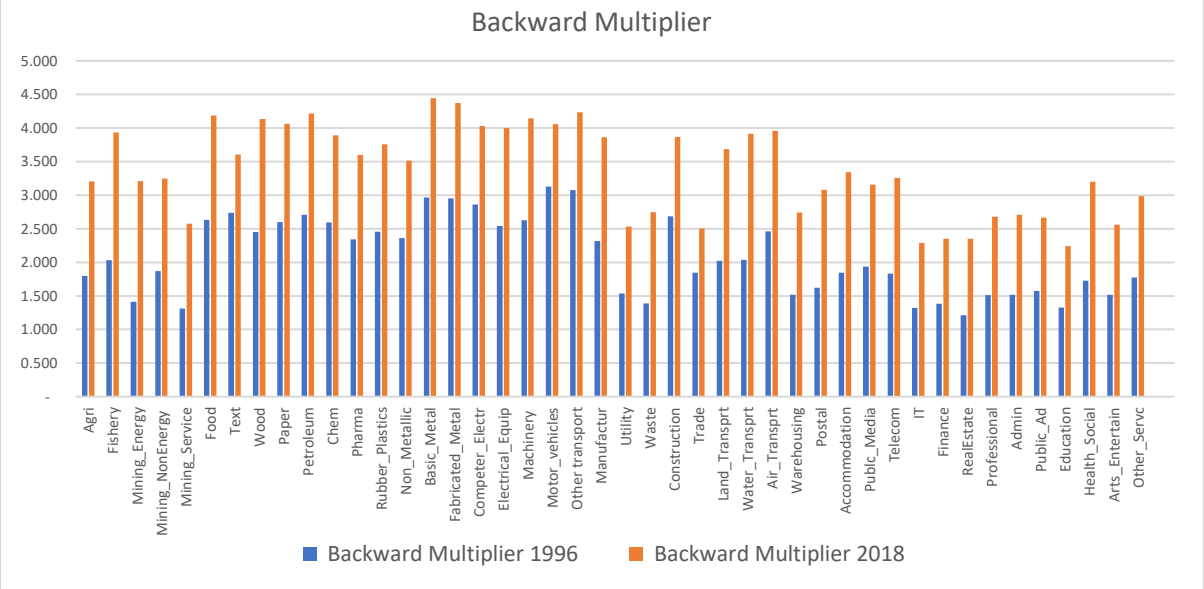

Figure 7: Changes in Backward Multiplier in the years 1996 and 2018

Source: Statistical data from the OECD Vietnam Input-Output Tables (IOTs) and calculations conducted by researchers.

	Forward Multiplier 2018	Forward Multiplier 1996		Forward Multiplier 2018	Forward Multiplier 1996
Agriculture, hunting, forestry	7.117	2.619	Electricity, gas, steam and air conditioning supply	3.356	2.226
Fishing and aquaculture	2.074	1.164	Water supply; sewerage, waste management and remediation activities	1.323	1.097
Mining and quarrying, energy producing products	7.664	2.405	Construction	2.037	1.193
Mining and quarrying, non-energy producing products	1.999	1.611	Wholesale and retail trade; repair of motor vehicles	8.367	5.404
Mining support service activities	1.099	1.044	Land transport and transport via pipelines	2.751	2.276
Food products, beverages and tobacco	5.147	1.457	Water transport	1.438	1.078
Textiles, textile products, leather and footwear	2.693	1.726	Air transport	1.366	1.452
Wood and products of wood and cork	2.390	1.327	Warehousing and support activities for transportation	2.348	1.433
Paper products and printing	4.090	2.169	Postal and courier activities	1.352	1.045
Coke and refined petroleum products	14.033	5.498	Accommodation and food service activities	2.121	1.242
Chemical and chemical products	9.246	2.950	Publishing, audiovisual and broadcasting activities	1.665	1.012
Pharmaceuticals, medicinal chemical and botanical products	2.758	1.199	Telecommunications	1.796	1.371
Rubber and plastics products	2.466	3.522	IT and other information services	1.770	1.056
Other non-metallic mineral products	2.206	2.560	Financial and insurance activities	3.834	2.421
Basic metals	11.224	5.413	Real estate activities	1.586	1.145
Fabricated metal products	6.438	2.287	Professional, scientific and technical activities	3.053	1.672
Computer, electronic and optical equipment	3.114	4.783	Administrative and support services	1.495	1.251
Electrical equipment	3.915	1.941	Public administration and defence; compulsory social security	1.227	1.377
Machinery and equipment, nec	4.591	2.317	Education	1.171	1.013
Motor vehicles, trailers and semi-trailers	1.932	2.835	Human health and social work activities	1.043	1.008
Other transport equipment	2.221	3.403	Arts, entertainment and recreation	1.195	1.004
Manufacturing nec; repair and installation of machinery and equipment	3.238	3.216	Other service activities	1.126	1.123

Table 2: A table displaying the Forward Multiplier values in each industry of Vietnam in the years 1996 and 2018

Source: Statistical data from the OECD Vietnam Input-Output Tables (IOTs) and calculations conducted by researchers.

	Backward Multiplier 2018	Backward Multiplier 1996		Backward Multiplier 2018	Backward Multiplier 1996
Agriculture, hunting, forestry	3.205	1.796	Electricity, gas, steam and air conditioning supply	2.532	1.537
Fishing and aquaculture	3.931	2.034	Water supply; sewerage, waste management and remediation activities	2.744	1.388
Mining and quarrying, energy producing products	3.209	1.410	Construction	3.866	2.683
Mining and quarrying, non-energy producing products	3.247	1.869	Wholesale and retail trade; repair of motor vehicles	2.503	1.847
Mining support service activities	2.577	1.311	Land transport and transport via pipelines	3.685	2.021
Food products, beverages and tobacco	4.186	2.630	Water transport	3.916	2.035
Textiles, textile products, leather and footwear	3.604	2.735	Air transport	3.956	2.461
Wood and products of wood and cork	4.134	2.453	Warehousing and support activities for transportation	2.743	1.515
Paper products and printing	4.062	2.600	Postal and courier activities	3.081	1.620
Coke and refined petroleum products	4.216	2.707	Accommodation and food service activities	3.342	1.848
Chemical and chemical products	3.890	2.595	Publishing, audiovisual and broadcasting activities	3.156	1.934
Pharmaceuticals, medicinal chemical and botanical products	3.601	2.344	Telecommunications	3.254	1.830
Rubber and plastics products	3.757	2.456	IT and other information services	2.289	1.320
Other non-metallic mineral products	3.511	2.361	Financial and insurance activities	2.350	1.384
Basic metals	4.443	2.964	Real estate activities	2.350	1.214
Fabricated metal products	4.370	2.950	Professional, scientific and technical activities	2.678	1.510
Computer, electronic and optical equipment	4.030	2.859	Administrative and support services	2.710	1.516
Electrical equipment	4.001	2.543	Public administration and defence; compulsory social security	2.666	1.572
Machinery and equipment, nec	4.145	2.625	Education	2.242	1.326
Motor vehicles, trailers and semi-trailers	4.058	3.129	Human health and social work activities	3.199	1.726
Other transport equipment	4.233	3.073	Arts, entertainment and recreation	2.560	1.517
Manufacturing nec; repair and installation of machinery and equipment	3.860	2.318	Other service activities	2.983	1.776

Table 3: A table displaying the Backward Multiplier values in each industry of Vietnam in the years 1996 and 2018

Source: Statistical data from the OECD Vietnam Input-Output Tables (IOTs) and calculations conducted by researchers.

4.3) Study of the Proportion of Intermediate Inputs to Production Cost

In the study of the proportion of intermediate inputs to production costs, it aims to analyze the extent to which each industry experiences changes in the proportion of intermediate inputs to production costs, reflecting the complexity and use of subcomponents in the production process, as well as the value of intermediate goods imported.

From Figure 8 and Table 4, when comparing the proportion of intermediate inputs to production costs across industries in Vietnam between 1996 CE (B.E. 2539) and 2018 CE (B.E. 2561), it is evident that in 2018 CE (B.E. 2561), each industry had a higher proportion of intermediate inputs to production costs. This reflects a more complex production structure with increased utilization of subcomponents, higher complexity in production processes, and higher values of intermediate goods. This change signifies a greater import of subcomponents. Notably, export-oriented industries such as Computer, electronic and optical equipment, Electrical equipment, Machinery and equipment, Motor vehicles, trailers, and semi-trailers, as well as Other transport equipment, had significantly higher proportions of intermediate inputs to production costs. This reflects an increased reliance on intermediate inputs and impacts the expansion of the domestic supply chain due to a higher demand for intermediate goods.

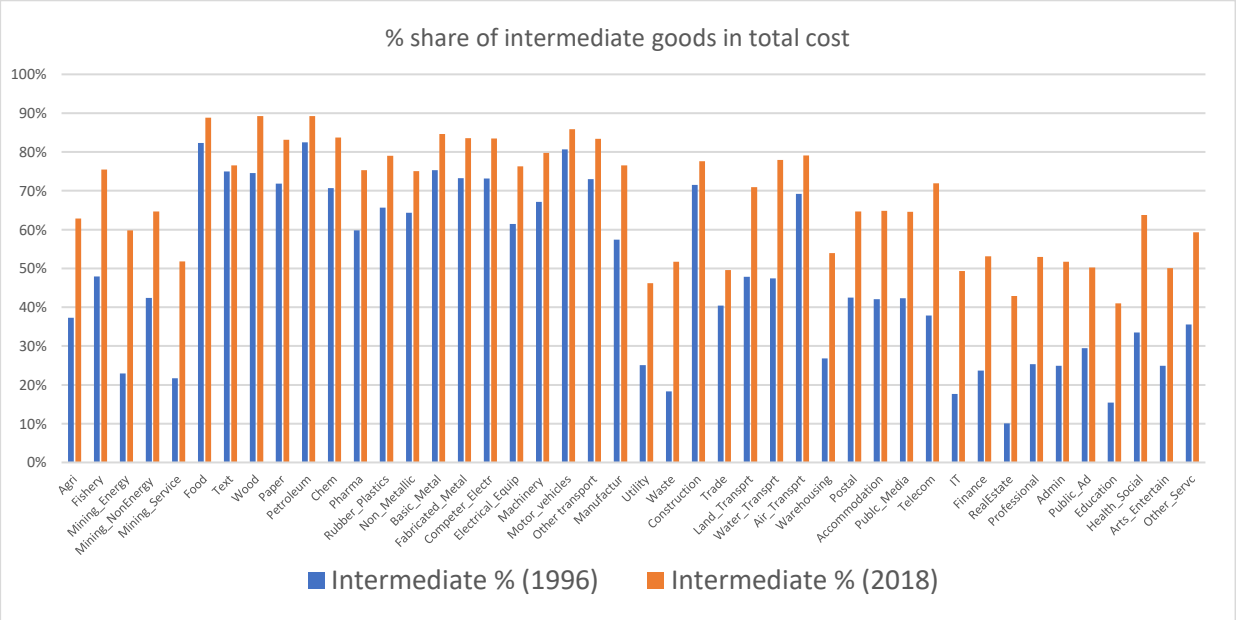

Figure 8: Proportion of Intermediate Inputs to Production Costs in 1996 and 2018

Source: Statistics from the OECD Vietnam Input-Output Tables (IOTs) database and calculations by researchers.

Table 4: Study of the Proportion of Intermediate Inputs to Production Costs in 1996 and 2018

	Intermediate % (2018)	Intermediate % (1996)		Intermediate % (2018)	Intermediate % (1996)
Agriculture, hunting, forestry	0.629	0.373	Electricity, gas, steam and air conditioning supply	0.462	0.250
Fishing and aquaculture	0.754	0.480	Water supply; sewerage, waste management and remediation activities	0.517	0.183
Mining and quarrying, energy producing products	0.598	0.230	Construction	0.776	0.715
Mining and quarrying, non-energy producing products	0.647	0.424	Wholesale and retail trade; repair of motor vehicles	0.496	0.404
Mining support service activities	0.518	0.217	Land transport and transport via pipelines	0.709	0.478
Food products, beverages and tobacco	0.889	0.823	Water transport	0.779	0.475
Textiles, textile products, leather and footwear	0.766	0.749	Air transport	0.791	0.692
Wood and products of wood and cork	0.892	0.746	Warehousing and support activities for transportation	0.540	0.268
Paper products and printing	0.831	0.719	Postal and courier activities	0.646	0.425
Coke and refined petroleum products	0.893	0.825	Accommodation and food service activities	0.648	0.421
Chemical and chemical products	0.837	0.707	Publishing, audiovisual and broadcasting activities	0.646	0.423
Pharmaceuticals, medicinal chemical and botanical products	0.753	0.598	Telecommunications	0.719	0.378
Rubber and plastics products	0.790	0.657	IT and other information services	0.493	0.177
Other non-metallic mineral products	0.750	0.643	Financial and insurance activities	0.532	0.237
Basic metals	0.847	0.753	Real estate activities	0.429	0.100
Fabricated metal products	0.835	0.732	Professional, scientific and technical activities	0.529	0.253
Computer, electronic and optical equipment	0.835	0.732	Administrative and support services	0.517	0.249
Electrical equipment	0.763	0.615	Public administration and defence; compulsory social security	0.503	0.294
Machinery and equipment, nec	0.798	0.671	Education	0.410	0.154
Motor vehicles, trailers and semi-trailers	0.859	0.806	Human health and social work activities	0.638	0.335
Other transport equipment	0.834	0.730	Arts, entertainment and recreation	0.501	0.249
Manufacturing nec; repair and installation of machinery and equipment	0.765	0.574	Other service activities	0.593	0.356

Source: Statistics from the OECD Vietnam Input-Output Tables (IOTs) database and calculations by researchers.

4.4) Studying Multiplier Changes through the Analysis of Change Diagrams

To investigate the details of the structural changes in Vietnam's economy and production characteristics, an analysis was conducted by comparing values in the years 1996 and 2018 using scatter plots. Two significant types of changes were identified.

In the first type of change, as shown in Figure 9, several industries experienced increases in both Backward and Forward Multipliers. These industries include Coke and refined petroleum products, Chemicals and chemical products, Basic metals and fabricated metal, Retail trade, Mining and quarrying, energy-producing products, and Agriculture, hunting, forestry. Figure 9 illustrates the increase in both Forward and Backward Multipliers, represented by the movement from the blue points (values in 1996) to the orange points (values in 2018), following a diagonal right-upward trend. When comparing the list of these industries, they largely align with the industries with high Weighted Degree Centrality Index values (as shown in Section 4.1). This reflects the consistency of results from both Network Analysis and Backward-Forward Multipliers, indicating that these industries are key mechanisms in Vietnam's economic system. These findings demonstrate that these industries have expanded the length and complexity of linkages in the supply chain, affecting both upstream

and downstream branches and exerting a significant economic impact on both sectors.

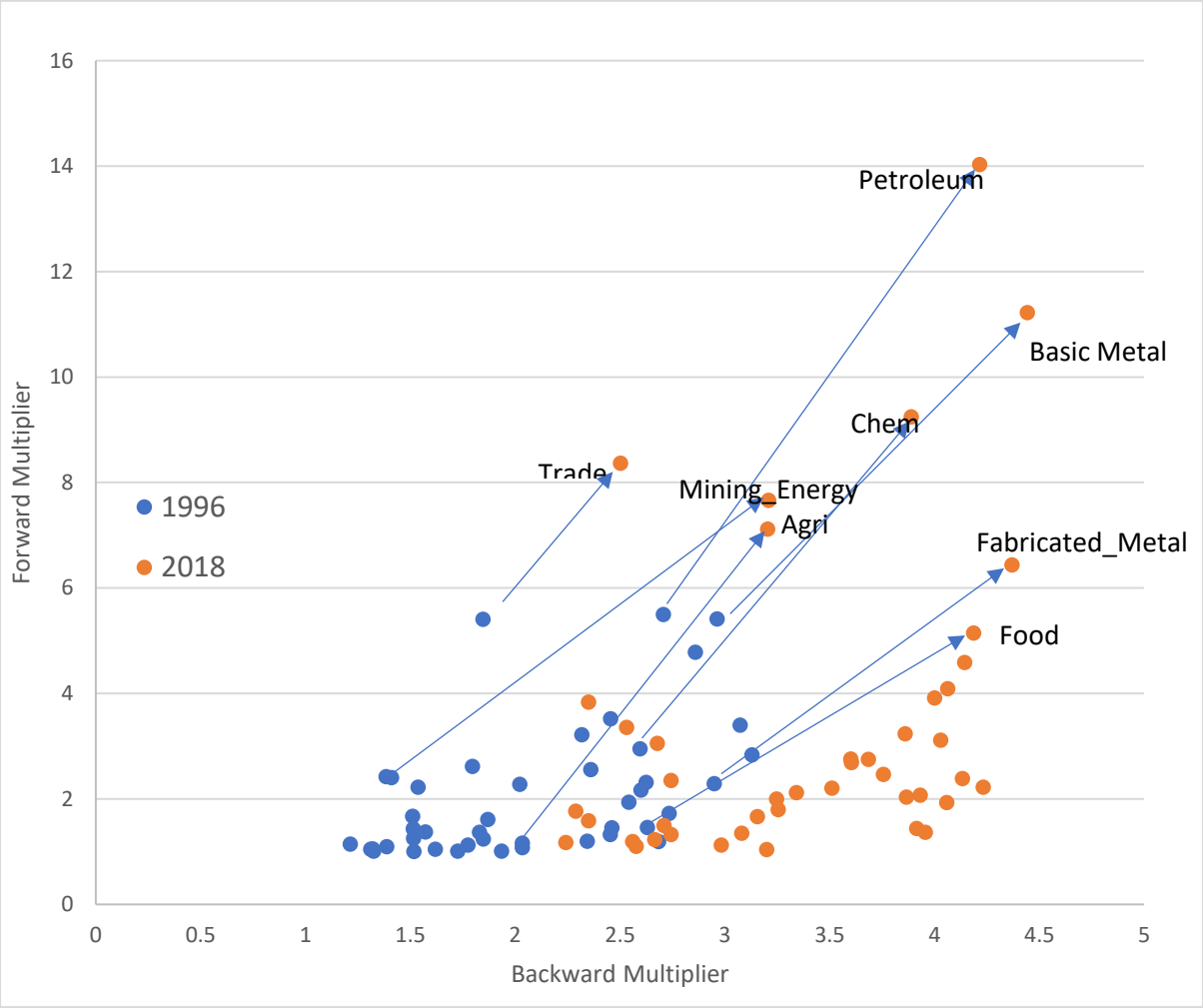

Figure Industries with Significant Changes in Backward-Forward Multipliers in Type 1 (Substantial Increases in Both Backward and Forward Multipliers)

Source: Statistics from the OECD Vietnam Input-Output Tables (IOTs) and calculations by the researchers.

At the same time, the analysis results reveal that the remaining manufacturing branches in Vietnam underwent changes in another pattern, as illustrated in Figure 10. Specifically, there was growth in the Backward Multiplier alone, while the Forward Multiplier increased slightly or remained almost unchanged. Consequently, there was a shift of the orange points to the right, as depicted. The results presented in Figure 10 indicate that most of Vietnam's industries experienced an increase in the Backward Multiplier, highlighting Vietnam's ability to position itself as a producer of downstream goods or as an

exporter of industrial products. In each industry, there was a greater proportion of intermediate inputs in the production cost, indicating an increased reliance on sub-components in production. These findings align with the conclusions in Section 4.3, which indicate that the majority of Vietnam's industries have increased their reliance on intermediate inputs, reflecting greater complexity in production processes. This development implies more intricate networks of component producers and intermediate goods and an expansion of linkages within the supply chain. Additionally, these branches are significant export sectors for Vietnam, such as the computer, electronic, and optical equipment industry, electrical equipment, machinery and equipment, and others. The cumulative results of the analysis are summarized in Table 5**.**

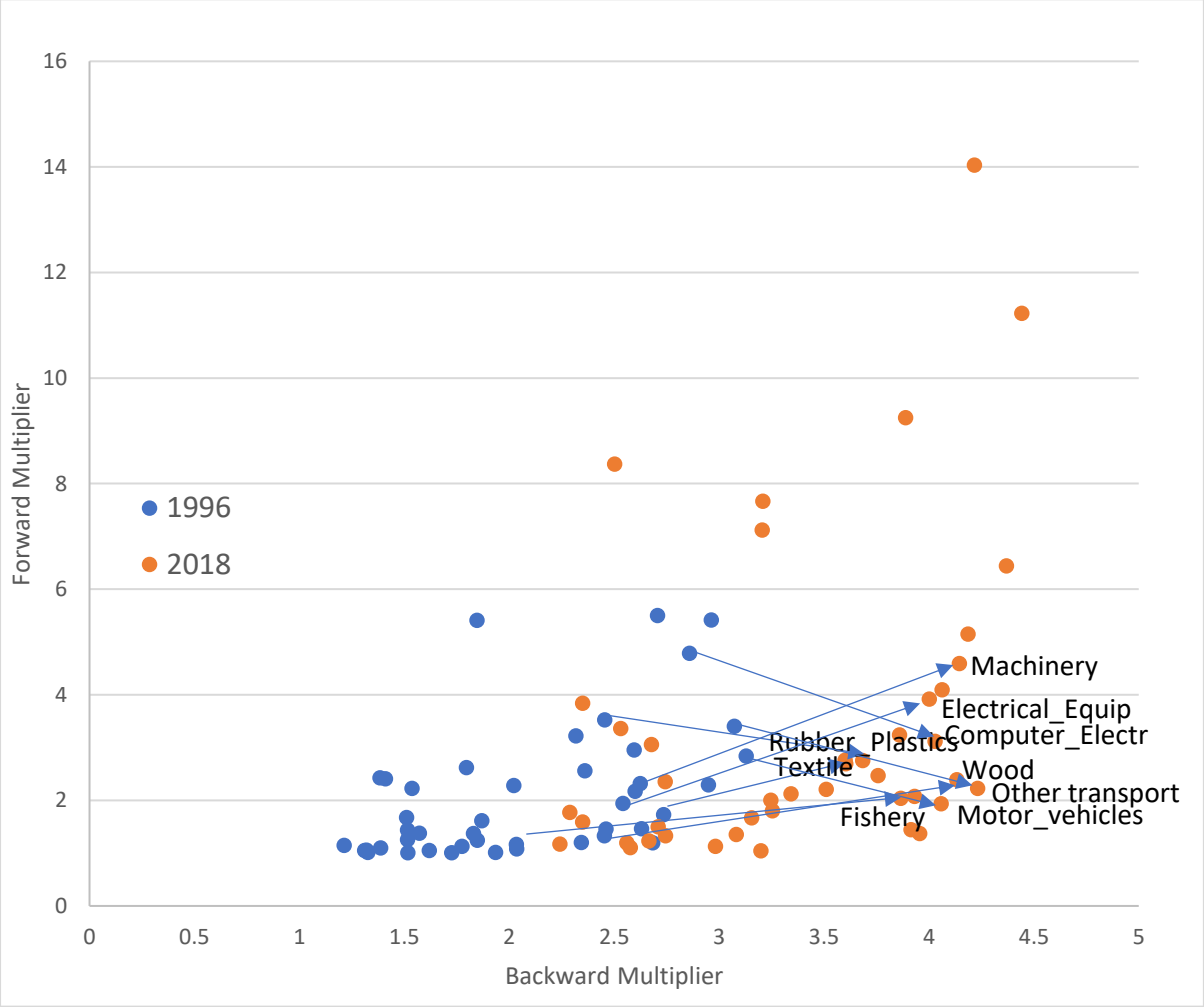

Figure 10: Industries with Significant Changes in Backward-Forward Multipliers in Type 2 (Predominantly Increased Backward Multiplier)

Source: Statistics from the OECD Vietnam Input-Output Tables (IOTs) and calculations by the researchers.

Table 5: Summary of Analysis Results Using Network Analysis and Backward-Forward Multipliers

Type	Role	Branch	Change in Weighted Degree Centrality Index	Change in Backward Multiplier	Change in Forward Multiplier	Change in Intermediate Input Proportion	Change in Export Proportion
1	Producing intermediate goods and serving as the main axis of the economic structure.	(1) Coke and refined petroleum products (2) Chemicals and chemical products, (3) Basic metals (4) Mining and quarrying, energy producing products (5) Agriculture, hunting, forestry (6) Wholesale and retail trade	High	High	High	High	Low (except for Agriculture sector)
2	Producing final goods and focusing on exports.	(1) Computer, electronic and optical equipment (2) Electrical equipment (3) Machinery and equipment (4) Motor vehicles	Moderate	High	Low	High	High

Source: Statistics from the OECD Vietnam Input-Output Tables (IOTs) and calculations by researchers.

5. Summary and Policy Recommendations (Conclusion)

5.1) Summary of the Study

When considering it through Network Analysis, it can be observed that in the year 1996, the industries that were important to the economy of Vietnam and formed the mainstay of production and linkages between production sectors consisted of light industries such as paper, non-metallic minerals, and general manufacturing industries. However, as time has passed, Vietnam has utilized the growth of the industrial sector as the primary mechanism to drive its economy. This has led to changes in the economic and industrial structure of Vietnam. In the year 2018, the results from Network Analysis show that the key industries now consist of the petroleum industry, chemicals, basic metals, and the wholesale-retail trade sector.

Furthermore, when considering these industry groups along with the values of Backward and Forward Multipliers, it is evident that these manufacturing sectors have the highest increases in both Backward and Forward Multipliers. This reflects the importance of these industries in the economy of Vietnam. While these industries may not be the primary export industries of Vietnam, the results from both methods of analysis clearly indicate their significance as foundational industries that produce intermediate goods and form the economic backbone of the country.

Additionally, the analysis of Backward and Forward Multipliers reveals that, besides the previously mentioned industry groups that constitute the primary sectors, most other industries in Vietnam have experienced increases in Backward Multipliers (with minimal changes in Forward Multipliers). This indicates their ability to transform themselves into producers of final goods or exporters of industrial products. These industries include steel manufacturing, computer and electronics, among others, and align with Vietnam's increasing ability to export industrial products and the corresponding increase in the proportion of intermediate inputs in production costs. This reflects the development of a production structure with more complex networks, extending production processes and linkages from downstream to upstream sectors.

5.2) Policy Recommendations

The government of Vietnam can utilize the data from this study for analysis and policy planning that align with the characteristics of industrial growth in the country. Furthermore, both the government and private sector of Thailand can use the analysis to monitor Vietnam's growth trends and seek economic cooperation opportunities, both in terms of trade and investment in Vietnam.

The analysis in this study highlights the varying characteristics of each industry in Vietnam based on the changes in Multipliers, which appear in two forms: (1) industries with increased Forward and Backward Multipliers and (2) industries with primarily increased Backward Multipliers. Therefore, Vietnam's government should implement tax policies that align with the characteristics of each industry group. Additionally, when entering into Free Trade Agreements (FTAs), Vietnam should consider aligning them with both types of industries. This would help Vietnam elevate itself as an exporter of goods to foreign countries with lower tax rates while simultaneously allowing the country to import goods or production components at lower tax rates. These measures would promote the growth of Vietnam's industries and align with the production structure that increasingly relies on intermediate inputs.

Moreover, both the Thai government and private sector can benefit from targeting specific industries to expand trade value or encourage Thai entrepreneurs to invest in Vietnam within these primary sectors. This would diversify the production base and create business linkage opportunities with existing production bases in the country. For example, Thailand's energy industry, which holds potential, could expand investments in Vietnam to take advantage of its growth and central role in Vietnam's economy within these industries.

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Note: The years in the Thai references have been converted from the Buddhist calendar to the Gregorian calendar for consistency.