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Vietnam Economic Structure and Greenhouse Gas Emission Based on Input-Output Analysis

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Abstract

Over the years, Vietnam has a relatively high growth rate of gross domestic product (GDP) compared to other countries in the region, an average increase of 6.1% in the period of 2005 - 2016. However, the macro instability such as the budget deficit, public debt, the economy's debt is always high, the environment is more risky. In Vietnam, in the reports, even research articles are automatically admitted that the structure of Region II (industry and construction) and Region III (service) in GDP needs to grow and see it as an economic development in the right direction. From that, the idea of economic restructuring is to promote both Region II and Region III; The investment rate of this area is increasingly higher, if it is always very high in 2005 to 2015, it was around 43% in 2005 and nearly 50% in 2016, but the irony is that the value-added ratio compared to the value of production of this sector (region II) fell surprisingly fast; this ratio follows the structure of 2000, the structure of the input-output tables in 2007 of General Statistics Office of Vietnam) is 34.1%, in recent years (the structure of the new input-output tables) is only 21%. This means that this region is increasingly inefficient, resulting in an increasing amount of investment to compensate for that inefficiency. This research is based on Vietnam economic structure from the input-output table, 2012, that was published by Vietnam General Statistics Office, this research focused to analysis deeper on sectoral structure, inter-sectoral and effects induced impacts by final demand to output, value-added and greenhouse gas (GHG) emissions based on the approach of input-output analysis. This study hopes to help policymakers make rational decisions for sustainable development in Vietnam

Keywords: Backward, Forward, Linkage, Power of Dispersion, Sensitivity of Dispersion, Greenhouse Gas

JEL Classification: D57, R10, C67, R19, O00, B40

Highlights of this paper

- This study uses an input-output analysis method to examine the current status of inter - industrial structures in the Vietnamese economy,
- The results show that Vietnam's economy is not sustainable. The policies seem to favor the industry that emits many greenhouse gas effects

I. Introduction

Over the years, Vietnam has a relatively high growth rate of gross domestic product (GDP) compared to other countries in the region, an average increase of 6.1% in the period of 2005 - 2016. However, the macro instability such as the budget deficit, public debt, the economy's debt is always high, the environment is more risky. In Vietnam, in the reports even research articles are automatically admitted that the structure of Region II (industry and construction) and Region III (service) in GDP needs to grow and see it as an economic development in the right direction. From that, the idea of economic restructuring is to promote both Region II and Region III. The investment rate of this area is increasingly higher, if it is always very high in 2005 to 2015, it was around 43% in 2005 and nearly 50% in 2016, but the irony is that the value-added ratio compared to the value of production of this sector (region II) fell surprisingly fast; this ratio follows the structure of 2000, the structure of the input-output tables in 2007 of General Statistics Office of Vietnam) is 34.1%, in recent years (the structure of the new input-output tables) is only 21% This means that this region is increasingly inefficient, resulting in an increasing amount of investment to compensate for that inefficiency.

The notion of economic structure was proposed by W. Leontief (1941) to analyze the structural change of the US economy based on the input-output tables in 1919 and 1929. Since then, input-output analysis method has been developed by many modelers such as W. Leontief (1970), Schoonbeek, L. (1990), Ebiefung, A.A., Udo, G. (1999), Dobos, I. and Floriska, A. (2005), Yu Fan et al. (2016) W. Leontief (1970), Schoonbeek, L. (1990), Ebiefung, A.A., Udo, G. (1999), Dobos, I. and Floriska, A. (2005), Yu Fan et al. (2016). In this study, some of the main structures of the Vietnamese economy are indicated by absorption matrix, which was developed by Chenery and Watanabe (1958), Interdisciplinary structure determined through intermediary costs and consumption and the relationship between production value, incremental value, and final demand.

Today, in parallel with the System of National Accounts (SNA), the United Nations also introduces a System of Environmental-Economic Accounts, SEEA, if the traditional input-output framework is the center of the System of National Accounts, then the Hybrid input-output framework is the center of the System of Environmental-Economic Accounts.

In Vietnam, there are also some studies that apply the input-output frameworks in the analysis and measurement of economic and environmental structures through waste matrix such as T. Bui (2011), T. Bui and Q. Bui (2017), Thai, N. Q. et al. (2019).

This study used the input-output tables in 2012 and the Greenhouse Gas (GHG) matrix published by the Ministry of Natural Resources and Environment in 2014.

II. Methodology

1. *Competitive and non-competitive input-output table*

The competitive input-output table includes both domestically manufactured and imported products, intermediary consumption, and final demand; the non-competitive input-output table is a table which has already separated the imported products from intermediary consumption and final demand.

Leontief relation of input-output table

$$A.X + Y = X \quad (1)$$

Where X is the production value matrix, $A = (a_{ij})$ is the direct cost factor matrix with $a_{ij} = X_{ij}/X_j$, Y is the final demand matrix

$$Y = C + G + I + E - M \quad (2)$$

Analysis of matrix A and vector Y by using domestic and imported products, equation (1) can be rewritten:

$$A^d.X + A^m.X + C^d + C^m + G^d + G^m + I^d + I^m + E = X \quad (3)$$

$$G^d + C^d + I^d + E = Y^d$$

And notice that $A^m \cdot X + C^m + G^m + I^m = M$

From equations: (1), (2) and (3), we have:

$$A^d \cdot X + Y^d = X \quad (4)$$

And Leontief relation for non-competitive input-output model has form:

$$X = (I - A^d)^{-1} \cdot Y^d \quad (5)$$

With $(I - A^d)^{-1}$ is the Leontief inverse matrix and Y^d is the domestic final demand matrix, including the final products in the country, accumulated products produced in the country, and exported products. The matrix X denotes the production value that is diffused by the elements of the final demand.

Back link is defined $B_j = \sum B_{ij}$; reflects the expansion of a sector when using other sector's products as input costs. Forward link $B_i = \sum B_{ij}$, indicates the level of production depending on inputs from other sectors. Guo and Hewings (2001) explain that increased back link will create a greater demand for inputs from other sectors and increased forward link will lead to changes in the sensitivity of the output to other sectors.

From these ideas, the diffusion index and the sensitivity of each sector are determined:

$$\text{Power of dispersion index: } P_j = B_j \cdot (n / T) \quad (6)$$

$$\text{Sensitivity of dispersion index: } S_i = B_i \cdot (n / T) \quad (7)$$

n is number of sectors in the input-output table

Where: n ; a number of sectors surveyed in the table I/O; $T = \sum B_{ij}$

Let v be vector as value-added coefficient with $v_i = V_i / X_i$. Here, V_i is the added value of sector i and X_i is the production value of sector i . From (5) we have:

$$V = v \cdot (I - A^d)^{-1} \cdot Y^d \quad (8)$$

Similarly, e is the direct emission coefficient matrix by sector with $e_{ij} = E_{ij} / X_j$. Here, E_{ij} is the amount of direct waste produced by sector j in the production process. From (5) we have:

$$E = e \cdot (I - A^d)^{-1} \cdot Y^d \quad (9)$$

From there we can estimate the vector of the factorial in terms of production value (GOM), value added (VAM), and Waste (EM) as follows:

$$GOM = X \div \sum Y \quad (10)$$

$$VAM = V \div \sum Y \quad (11)$$

$$EM = E \div \sum Y \quad (12)$$

Where: \div shows scalar division

III. Research results

About indexes of power of dispersion and sensitivity for dispersion

The research results about diffusion index and sensitivity from Table 2 shows that group of agriculture, forestry and fishery (sector no.1), group of food processing industry, beverages and tobacco (sector no.3), production of products from oil and gas (sector no.5) and other manufacturing industries (sector no.10) have both the sensitivity and diffusion higher than the general average of the economy quite a lot, this shows that these 4 groups not only strongly stimulate other sectors in the economy but also make the input needs of the economy quite large. Most service industries do not have good diffusion and sensitivity, especially in the scientific and technological industries have the level of diffusion and sensitivity lower than the average level, this shows that the group of the sector does not diffuse anywhere and sectors in the economy do not need it much.

Table 1. Backward linkage, forward linkage, Power of dispersion and sensitivity for dispersion of the Vietnam economy (equations 5, 6, 7)

No.	Economic sector	2012			
		Back Linkage (BL)	Power of dispersion index	Forward linkage (FL)	Sensitivity of dispersion index
1	Agriculture, forestry, and fishery	1.688	1.104	2.299	1.504
2	Mining	1.396	0.913	2.219	1.452
3	Food processing industry, beverages, and tobacco	2.263	1.480	1.657	1.084
4	Production of textile products, costumes, and leather goods	1.551	1.014	1.364	0.892
5	Production of products from oil and gas	1.749	1.144	1.923	1.258
6	Production of chemical products	1.558	1.019	1.461	0.955
7	Production of non-metallic mineral products	1.582	1.035	1.304	0.853
8	Manufacturing and processing metals and metal products	1.464	0.957	1.752	1.146
9	Manufacturing equipment and machinery	1.377	0.901	1.294	0.846
10	Other manufacturing industries	1.778	1.163	2.489	1.628
11	Production and distribution of electricity, gas, hot water, steam, and air conditioning	1.183	0.774	1.337	0.874
12	Water supply; waste and wastewater management and treatment	1.385	0.906	1.106	0.724
13	Construction	1.697	1.110	1.153	0.754
14	Transportation of warehouses	1.603	1.048	1.442	0.943
15	Wholesale and retail; Hotel and restaurant	1.466	0.959	1.722	1.126
16	Information and communication	1.538	1.006	1.420	0.929
17	Financial activities, banking, and insurance	1.363	0.892	1.546	1.011
18	Professional, scientific and technological activities	1.355	0.886	1.229	0.804
19	Education and training	1.184	0.775	1.029	0.673
20	Health and social assistance activities	1.655	1.082	1.008	0.659
21	Other service sectors	1.271	0.831	1.353	0.885

Source: Calculations from I/O table 2012 of Vietnam General Statistics Office

Value-added and import multipliers (equations: 3,4,8)

In many cases, the increase in demand-side stimulates the supply side but at the same time stimulates imports and does not induce so much to value-added, further research has shown that although some sectors (sector number 4) was induced impacts strongly to production but how does it induce to value-added ($GDP = \sum \text{value-added} + \text{tax on product}$), and how it does not induced to imports? A sector that is considered as a high importance is high sensitivity and diffusion index sectors, but it is low diffusion to imports and high diffusion to value-added. Table 3 shows that in the four sectors with high sensitivity and diffusion index, only the agriculture, forestry, and fishery sectors met this requirement. Most sectors of the manufacturing and processing industries have a high sensitivity and diffusion index but strongly stimulate the import and diffusion to the value-added is much lower than the general average. This shows that the manufacturing and processing industries in Vietnam are mainly outsourcing and the level of outsourcing is increasingly high. Interestingly, most service sectors with a low diffusion index to imports, and diffusion to added value are higher than the average, but these sectors have relatively low sensitivity and diffusion index to output. In order to improve this issue, it may give an important

solution is that if Vietnam enhances its auxiliary products to meet inputs for a group of the service sector, and service sector must also develop to meet the needs of other sectors in the economy. This will lead to increased sector linkages through increased diffusion and sensitivity, thereby creating a strong motivation for the economic development of the country. However, "policy resources," especially tax policy, are not aimed at this issue. For example, on indirect tax, there are two issues: First, indirect tax for FDI enterprises are entitled to enjoy preferences on tax policies, most FDI enterprises do the outsourcing and export, these enterprises, due to direct export, so the input of imports get tax incentives, while local enterprises are not entitled to get tax incentives if they are in domestic sales, we can see that the call on the production of auxiliary products for the past 10 years cannot become true? The import-export tax policy does not show any action, it shows the flatness among different types of businesses and secondly, when most of the production in Vietnam is outsourced, the Vietnamese people in fact use Vietnamese goods as well as use imported goods in other forms only, use the products of FDI enterprises in this case too, so the contribution of the FDI region to the budget needs to be differentiated between indirect taxes and direct taxes, because the indirect tax is paid by the Vietnamese people to the budget, FDI enterprises contribute only corporate income taxes.

Table 2. Value added and import multipliers

No.	Economic sector	2012		
		Diffuse to added value	Average diffuse index to the added value	Average diffuse index to import
1	Agriculture, forestry, and fishery	0.684	1.024	0.952
2	Mining	0.654	0.979	1.042
3	Food processing industry, beverages, and tobacco	0.625	0.935	1.130
4	Production of textile products, costumes, and leather goods	0.560	0.838	1.327
5	Production of products from oil and gas	0.483	0.722	1.560
6	Production of chemical products	0.511	0.765	1.474
7	Production of non-metallic mineral products	0.663	0.992	1.016
8	Manufacturing and processing metals and metal products	0.431	0.645	1.716
9	Manufacturing equipment and machinery	0.388	0.581	1.845
10	Other manufacturing industries	0.538	0.806	1.392
11	Production and distribution of electricity, gas, hot water, steam, and air conditioning	0.879	1.316	0.364
12	Water supply; waste and waste management and treatment	0.772	1.154	0.689
13	Construction	0.578	0.864	1.274
14	Transportation of warehouses	0.604	0.904	1.193
15	Wholesale and retail; Hotel and restaurant	0.798	1.195	0.608
16	Information and communication	0.682	1.020	0.959
17	Financial activities, banking, and insurance	0.869	1.300	0.396
18	Professional, scientific and technological activities	0.822	1.230	0.536
19	Education and training	0.928	1.388	0.218
20	Health and social assistance activities	0.680	1.018	0.964
21	Other service sectors	0.886	1.325	0.345

Source: Calculations from I/O table 2012 of study group

Impacts on the environment (equation: 9)

This study focused on greenhouse gas emissions generated during production. Table 3 shows the sector groups number 1, 2, 3, 7, 10, 12, 13 has a higher level of greenhouse gas emissions than the economy average. Especially, the No. 7 sector (Production of non-metallic mineral products) has a greenhouse gas emission of 3.5 times higher than the average level, the No. 1 sector (Agriculture, forestry, and fishery) has a greenhouse gas emission of 2.6 times higher than the average and sector 13 (construction) has emissions. 2.5 times higher than the average level

Notably, the agriculture, forestry, and fishery sectors have taken into account the uptake of greenhouse waste from the forestry sector, but the greenhouse gas emissions of this sector are still higher than the average emission of more than 2.5 times.

Final demand of services sector group induced to high value-added and greenhouse gas low at almost sectors.

Table 3. Greenhouse gas emissions from production

No.	Economic sectors	2012	
		Greenhouse emissions (GHG) are induced by added one unit in final demand	Influence level average
1	Agriculture, forestry, and fishery	0.103	2.573
2	Mining	0.044	1.104
3	Food processing industry, beverages, and tobacco	0.060	1.497
4	Production of textile products, costumes, and leather goods	0.017	0.427
5	Production of products from oil and gas	0.029	0.714
6	Production of chemical products	0.025	0.636
7	Production of non-metallic mineral products	0.141	3.523
8	Manufacturing and processing metals and metal products	0.012	0.302
9	Manufacturing equipment and machinery	0.024	0.602
10	Other manufacturing industries	0.069	1.732
11	Production and distribution of electricity, gas, hot water, steam, and air conditioning	0.017	0.417
12	Water supply; waste and waste management and treatment	0.080	1.998
13	Construction	0.099	2.472
14	Transportation of warehouses	0.021	0.527
15	Wholesale and retail; Hotel and restaurant	0.021	0.534
16	Information and communication	0.019	0.479
17	Financial activities, banking, and insurance	0.003	0.081
18	Professional, scientific and technological activities	0.009	0.228
19	Education and training	0.005	0.123
20	Health and social assistance activities	0.025	0.633
21	Other service sectors	0.016	0.398

Source: The author's calculation based on the table I/O 2012 and reports of the Ministry of Natural resources and Environment.

Induced impacts of factors of final demand to output, value-added, import and greenhouse gas (equation: 10, 11, 12)

Table 4 shows that exports of commodities diffuse to the lowest added value, but strongly diffuse to imports, and it is more dangerous that production for exports of commodities is the largest source of greenhouse gas emissions among the elements of the final demand, Meanwhile, service exports produced the least greenhouse gas emissions but generated the most added value

According to the report of the Ministry of Natural Resources and Environment, it is estimated that by 2010 Greenhouse gas emissions GHG will be around 247 million tons, the calculation of the study group shows that GHG will be 300 million tons by 2012, which has an average annual increase of 10% while on the average GDP increased approximately 6% from 2010-2012. It is seemed illogical to the export priority policy both in terms of tax and credit policies. It seems that resources on policy showed the wrong place one more time.

Table 4. *Induced impacts of factors of final demand to output, value-added, import and greenhouse gas*

	Final consumption	Gross capital formation/ Accumulation	Exports of goods	Exports of services	Total (Million tons)
Output	1.744	1.799	1.788	1.601	
Value added	0.72	0.58	0.56	0.76	
import	0.28	0.42	0.44	0.24	
greenhouse gas emissions (million tons)	77	65	152	6	300
Structure of GHG	25.70%	21.70%	50.70%	1.90%	100%

Source: *The calculations based on the table I/O of the study group and data of the Ministry of Natural resources and Environment*

IV. Conclusion

The result of study shows that the current economic structure and policy priorities is not towards the sustainable growth, meanwhile on the average the GDP in the period of 2005-2017 has been increased around 5.7% (GDP growth in 2017 is 6.81%) and in 2017 manufacturing and processing industries have been increased by 14.5% (according to comparative price), corresponding to 8-10% of greenhouse gas emission growth. Accordingly, by 2020 if the economic structure has not been changed and the green growth has not been invested, greenhouse gas emissions (GHG) will be 550 million tons, which is higher than that forecasted by United Nation to Vietnam (by 2020 it can be 466 million tons).

In terms of manufacturing industries, the processing industry diffuses to a low added value but high greenhouse gas emissions.

In terms of demand, exports of goods diffuse to a low added value but the highest greenhouse gas emissions among the elements of the final demand (final consumption, asset accumulation, exports of goods and services). However, all policies seem to be in favor of exports. It is a waste of policy resources.

Recommendations

It is necessary to choose the appropriate policy for sustainable development, such as:

1. There should be consistent and harmonious policies not only between institutional sectors such as State-owned enterprises, FDI enterprises, non-state owned enterprises, and household sectors but also between the enterprises in the same type of institution.

2. Agro-forestry-fisheries sector has all economic indicators such as diffusion, sensitivity to good production, and added value, but it also a major cause of greenhouse gas emissions. Policy, capital, high-quality labor resources are necessary to progress to green agriculture for this sector.
3. The result of the study are similar to Nguyen Hong Son's study on "Service in Vietnam 2020: Towards quality, efficiency and modernity"⁸ as service sector diffuse well to income and less greenhouse gas emissions, but diffuse to production values and sensitivity is slightly low. If diffusion and sensitivity of this sector increase, the growth is not only high, enough quality, but also sustainable. For increase of diffusion and sensitivity, real specific priority policy is necessary for domestic auxiliary industries, particularly auxiliary production sectors for the input of the service sectors.
4. The study shows that the most important resource for sustainable and fast development is "policy resource." It is necessary to determine the specific destination, growth without environment, or sustainable growth? If GDP growth in all costs does not need macroeconomic instability such as debt, overspending, and environmental damage, this study will not make sense!
5. A flexible policy is necessary to deal with the elements of the final demand. This study shows that at the moment, the exports do not diffuse much to added value; only the imports and greenhouse gas emissions (GHG) are the biggest among the elements of the last demand.
6. Promote science, technology, and innovation under new institution, the quality of human resources needs to be improved urgently and in fact, to structure the income in total added value.

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Appendix

Sectors in research

No.	Economic sector
1	Agriculture, forestry and fisheries
2	Mining industry
3	Production of foods, beverages and cigarettes
4	Production of textile products, costumes and leather products
5	Manufacturing petroleum and gas products
6	Production of chemical products
7	Production of non-metallic mineral products
8	Manufacturing and processing metals and metal products
9	Production of equipment and machinery
10	Other manufacturing and processing industries
11	Production and distribution of electricity, gas, hot water, steam and air conditioner
12	Water supply; Waste water, sewage management and treatment activities
13	Construction
14	Logistics
15	Wholesale and retail; Hotel and restaurant
16	Information and communication
17	Financial, banking and insurance activities
18	Professional, scientific and technological activities
19	Education and training
20	Health and social support activities
21	Other service sectors