Economic Structure and Greenhouse Gas Emission of Vietnam

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Abstract: *The relationship between economics with the environment has long been of interest to researchers, Since 1970 the input - output system of W. Leontief has been applied for economic - environmental linkage analysis. This research extended the standard input - output system and Miyazawa's demographic - economic model (1976) to hybridise input - output (H.I.O) system for analyzing the linkage between economic - environmental based on Vietnam input - output table in 2016. This framework gave us the model suggestion as systematic tools which be used for integrated economic - environmental analysis and planning.*

Key Words*: input-output, greenhouse gas, income, consumption*.

I.Introduction

In terms of economic growth, the average of GDP growth rate in the period of 2010 - 2016 about 6.2% is quite good growth for comparing to other countries in the area. On the supply growth of Vietnam in 2017 mainly based on the growth of the manufacturing industry (14.5%) is much higher than the GDP growth rate of the economy (6.8 %). On the demand growth of export, the rate is up to 21%, if excluding factors price, export growth of 9%. These two factors are related to each other because the manufacturing industry is basically processing and then exporting, the economic sector has the high proportion of the total export turnover is FDI (73%) [1]

However, research from the input - output framework, greenhouse gas emissions (Greenhouse Gas - GHG) of Vietnam are really alarming, especially in the two indicators which is proud of manufacturing and exporting of goods.

The linkage between pollution matrix and economic structure has mentioned by many researchers such as W. Leontief (1970, 1986) [2,3], Miller and Blair (1985) [4],Schoonbeek, L.(1990) [5], Ebiefung, A.A., Udo, G. (1999),[6] Xiaoming Pan and Steven Kraines (2001) [7], Dobos, I. and Floriska, A. (2005), [8]

Nowadays, in parallel with the National Accounts System (SNA), the United Nations also introduced System of Environmental - Economic Accounts (SEEA). The traditional input - output framework is the center of SNA and the hybrid input - output framework is the center of SEEA system [9].

In Vietnam, there are a few studies on using input - output system to analyze and measure the linkages between economic and environmental as T.Bui & Phong N. V (2013), T. Bui & Hoa P. L (2017), T.Bui & Q. Bui (2017) [10-12]. In these papers, in order to estimate emissions for Vietnam by sector, they have to borrow direct emission coefficient vector of others countries, in a paper of T. Bui and Hoa P. L borrowed this vector of China in order to measure the impacts of economic activities to environmental.The paper of T.Bui & Q.Bui used the Vietnam input - output table in 2012. This study on extended these researches in 2016.

This study on extended the input - output system standard and Miyazawa's demographic - economic model to hybrid input - output (H.I.O)

system for analyzing the linkage between economic - environmental based on Vietnam input - output table. This framework gave us the suggested model as systematic tools that can be used for integrated economic - environmental analysis and planning. It is different fromideas hybrid input - output framework of Environmental - Economic Accounts System of UN.

Data sources: The Vietnam input - output table in 2016[1] and the greenhouse gas emission ratios directly by sector collected from the Ministry of Natural Resources and Environment (MONRE) by the report "THE INITIAL BIENNIAL UPDATED REPORT OF VIET NAM TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE"[13] - Name of sectors in the input - output table in appendix 1.

II. Methodology

Based on Leontief's input - output system (1936, 1941)[14,15]and Miyazawa's demographic - economic model (1976) [16], In the input - output with non - competitive - import type, we have:

$$A^d.X + C + F = X \quad (1)$$

Where X is the gross output matrix, $A^d = (a^d_{ij})$ $(_{n\ x\ n})$ is the domestic direct intermediate input coefficient matrix with $a^d_{ij} = X^d_{ij} / X_j$, X^d_{ij} presents sector j used domestic product i for intermediate input, Xj is output of sector j, C is a vector of final consumption and F is a matrix of remain domestic final demand

And:

$$\sum^n_i V^1_i + V^2 = V \quad (2)$$

With: V^1_i is income from production of sectors i, V^2 is exogenous income, and V is vector of total income.

$Putv^1_i = V^1_i/X_i$ and $c_i = C_i/V$

The equation (1) and (2) can re-write:

$$A^d.X + c.V + F = X \quad (3)$$

$$v^1.X + V^2 = V \quad (4)$$

Of course, V also can be a vector of total income for some r-fold division of income groups, V^2 is a vector of exogenous income for r-fold income groups and $v^1.X$ is a matrix of income for r-fold endogenous income groups, where v^1 is a matrix of income ratios for r-fold endogenous income group

Re-write equation (3) and (4) in matrix form:

$$\begin{pmatrix} A^d & c \\ v^1 & \end{pmatrix} *. \begin{pmatrix} X \\ V \end{pmatrix} + \begin{pmatrix} F \\ V^2 \end{pmatrix} = \begin{pmatrix} X \\ V \end{pmatrix} \quad (5)$$

Call: $B = \begin{pmatrix} A^d & c \\ v^1 & \end{pmatrix}$

We have:

$$\begin{pmatrix} X \\ V \end{pmatrix} = (I - B)^{-1}. \begin{pmatrix} F \\ V^2 \end{pmatrix} \quad (5)$$

Assume that total volumn of residuals (E) includes residuals from production (E^1) and residuals from consumption (E^2), we have:

$$E^1 + E^2 = E \quad (6)$$

Define: The coefficient vector $e = (e^1, e^2)$, with:

$$e^1_i = E^1_i/X_i \quad (7)$$

$$e^2 = E^2/V \quad (8)$$

So we have:

[1] The Vietnam input – output table was updated by Vietnam Development Research Institute (VIDERI)

$$(e^1, e^2).\begin{pmatrix} X \\ \\ V \end{pmatrix} = E = (e^1, e^2).(I - B)^{-1}.\begin{pmatrix} F \\ \\ V^2 \end{pmatrix} \quad (9)$$

So, we have to calculate inter -sectoral structure of economic activities and volumn and structure of greenhouse gas.

III. Some Findings

1. Inter - sectoral structure

Backward and forward linkages

The Backward and forward linkages can be calculated from standard Leontief system

Backward linkage is a vector that defined: $BL = \sum_i (I - A^d)^{-1}$; refers to the expansion of an industry when using other industry products as inputs.

Forward linkage is a vector that defined: $FL = \sum_j (I - A^d)^{-1}$; indicates the level of production depends on input from other sectors.

Guo and Hewings (2001) [17] argued that increased backward linkage will generate greater demand for inputs by other industry and increased forward linkages will lead to change in output sensitivity in other sectors.

And:

Power of dispersion index is defined: $Pi = BLi.n./(\sum BLi)$

Sensitivities for dispersion index is defined: $Si = FLi.n/(\sum FLi)$

Where: n is number of sectors in input-output model

Table 1 show that agriculture, forestry and aquatic product (sector 1), food processing, beverage and tobacco (sector 3), the production of oil and gas products (sector 5) and other manufacturing industries (sector 10) have both Power of dispersion and sensitivity for dispersion indexes higher than the general average of the economywhich suggests that these four sectors are not only strong stimulate other sectors of the economy but the input demand for the economy is quite large. Most of service sectors doesn't have good backward and forward linkages index. Especially in the specialized scientific and technological operational sector where power of dispersion and sensitivity for dispersion are significantly lower than the overall average, suggesting that this sector does not spread which industries in the economy also doesn't need it.

Table 1.Induced impacts of a unit of final demand

NO.	Backward linkage	Power of dispersion	Forward linkage	Sensitivity for dispersion
1	**2.181**	**1.109**	**3.18**	**1.616**
2	1.761	0.895	2.7	1.373
3	**2.769**	**1.408**	**2**	**1.017**
4	1.968	1	1.658	0.843
5	**2.207**	**1.122**	**2.994**	**1.522**
6	**2.128**	**1.082**	**2.164**	**1.1**
7	2.153	1.094	1.693	0.861
8	1.935	0.983	2.764	1.405
9	1.747	0.888	1.977	1.005
10	**2.252**	**1.145**	**3.521**	**1.79**
11	1.505	0.765	1.563	0.795
12	1.819	0.925	1.167	0.593
13	2.11	1.073	1.229	0.625
14	2.068	1.051	1.731	0.88
15	1.905	0.968	2.23	1.134
16	1.908	0.97	1.654	0.841
17	1.775	0.903	1.917	0.974
18	1.819	0.925	1.515	0.77
19	1.542	0.784	1.045	0.531
20	2.08	1.057	1.011	0.514
21	1.679	0.854	1.597	0.812

Source: Calculated from I/O table 2016 was updated Vietnam Development Research Institute (VIDERI).

Induced impacts of value added and import caused by a unit increase of final demand

Research on sensitivity and spread as above are possible to talk about the spread of final

demand to the value of production(output). In many cases, the demand side stimulates the supply side but contemporaneousstimulates imports does not spread much to added value. Further research shows that although some sectors (4 sectors) are strongly spreading but how does it spread to the value added, import? An industry considered as a high important industry which has high spread index, high sensitivity but spread to import low and added value high. Table 2 shows that in the four sectors which has high spread and sensitivity. Only the Agro Forestry Fisheries meets this requirement. Most of the sectors in manufacturing industry has a high spread and sensitivity index but strongly stimulate to import coeval spread to the added value much lower than the average. This shows that the processing industry in Vietnam is mainly processing,the level of processing is increasingly higher. Interestingly, almost all service sectors has low spread index and spread to the added value higher than average, these sectors has spread index and sensitivity to output low.

Table 2. Induced impacts of value added and import caused by a unit increase of final demand

No.	Degree of spread to Value added	Degree of spread to Import
1	**1.05**	0.922
2	0.96	**1.062**
3	0.953	**1.074**
4	0.839	**1.251**
5	0.707	**1.456**
6	0.809	**1.297**
7	**1.016**	0.975
8	0.678	**1.502**
9	0.615	**1.6**
10	0.844	**1.243**
11	**1.253**	0.606
12	**1.133**	0.793
13	0.883	1.183
14	0.911	**1.138**
15	**1.189**	0.706
16	0.998	1.003
17	**1.309**	0.517
18	**1.171**	0.733
19	**1.363**	0.434
20	**1.008**	0.988
21	**1.311**	0.515

Source: Calculated from I/O table 2016 was updated Vietnam Development Research Institute (VIDERI)

Impacts on the environment

In this research, due to the limited data source so only research the impact of economic on Greenhouse gas emissions (GHG). Calculated based on reports of Ministry of Natural Resources and Environment on climate change[2], the results show that the economic indicators of Agro Forestry Fisheries have impressive indicators, the current status of economic structure shows waste in this sector discharged into the environment Greenhouse gas emissions two times higher than overall emissions of the economy.The sector which have Greenhouse gas emission ismanufacturing non-metallic mineral product group (Sector 7), higher than the average of 3.3 times, followed by the construction industry (2.39 times), Agro Forestry Fisheries (2.36 times); Supply water; Management and processing garbage, sewage; Other manufacturing industries; Manufacture of food, beverage and tobacco; Extractivehave greenhouse gas emissions higher than the overall average of the economy. It is noteworthy that almost everyone thinks the

[2]Ministry of Natural Resources and Environment "THE INITIAL BIENNIAL UPDATED REPORT OF VIET NAM TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE" VIET NAM PUBLISHING HOUSE OF NATURAL RESOURCES, ENVIRONMENT AND CARTOGRAPHY, 2014

shipping industry has greenhouse effect emission high but it is not that, the shipping industry emits amounts of CO2 relatively high but does not emit much CH_4 and N_2O. ***Most service groups not only spread to income highly but also spread to air environments low***.

Table 3.Greenhouse gas induced by final demand

No.	GHG emission induced by a unit final product	Compare with average
1	0.112	**2.369**
2	0.048	**1.021**
3	0.069	**1.449**
4	0.022	0.458
5	0.031	0.646
6	0.033	0.692
7	0.158	**3.333**
8	0.016	0.340
9	0.029	0.608
10	0.080	**1.696**
11	0.021	0.455
12	0.088	**1.865**
13	0.113	**2.393**
14	0.027	0.564
15	0.028	0.590
16	0.024	0.511
17	0.007	0.154
18	0.014	0.303
19	0.012	0.262
20	0.036	0.751
21	0.026	0.540

Source: Calculated from I/O table 2016 was updated Vietnam Development Research Institute (VIDERI)

Table 4 shows that manufacturing export production has the highest GHGemission (47.5) in the elements of final demand. This is in contrast to the preferential policy of good export of both tax policy and credit policy. It seems that capital and policy resources once again in wrong place.

In the report of Ministry of Natural Resources and Environment2013,the amount of GHG emission is about 293 million tons, according to the researcher team, the amount is 423 million tons in 2016. A report by the Ministry of Natural Resources and Environment forecasts to 2020, the amount of Greenhouse gas emissions is 466 million tonsso 2016 the amount is 423 million tons. The average growth of Greenhouse gas emission from 2010 to 2016 is about 8%, increase faster than the average GDP growth rate in this period (about 6.1%)

Table 4.GHG was induced by factors of final demand

	Final consumption*	**Gross capital formation**	**Export of goods**	**Export of Services**	**Total (Million ton)**
GHG emission (Million ton)	115	100	201	7	**423**
Structure	27.19%	23.64%	47.52%	1.65%	100%

(*): GHG emission includes indirect and direct emission caused by final consumption.

To emphasize conclusions, applying the relationship (9) when final consumption is introduced as a production sector for comparison, it can be seen that the final consumption has the spread of GHG emissions lower than the average (0.77). This calculation also shows that most service sectors spread to income well and to GHG emissions low, while most industries do not spread to income well but they cause huge GHG emissions.

Table 5.Income and GHG multipliers

	Income multipliers	Degree of spread to GHG
1	1.091	1.780
2	0.998	1.004
3	0.990	1.234
4	0.872	0.641
5	0.735	0.682
6	0.841	0.754
7	1.055	2.289
8	0.705	0.501
9	0.639	0.618
10	0.877	1.317
11	1.302	0.832
12	1.177	1.544
13	0.917	1.715
14	0.947	0.733
15	1.235	0.876
16	1.037	0.744
17	1.360	0.695
18	1.217	0.712
19	1.416	0.779
20	1.047	0.879
21	1.362	0.906
		0.766
Consumption		

Source: Calculated from I/O expansion, 2016

IV. Conclusions

Research shows that the I-O model is a powerful, effective and flexible tool in the linkage of economic and environmental research.

It shows that Vietnam does not seem to pay attention to environmental factors and sustainable development. With the economic structure and policy priorities as Vietnam are applying, it shows that the economy not only pollutes the air but also does not inefficient in economics. Vietnam should has green marketing towards green purchase behavior, Muhammad Abid and Tehreem Abdul Latif [18]On the supply side: Vietnam's industry group which is proud of with a high growth rate as the manufacturing industry has the spread to income low while spread to importing and emitting into the environment highly.

On the demand side: Priority policies seem to be directed at exports, the study shows that manufacturing export productions causes the greatest greenhouse gas emissions in the elements of the final demand.

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Appendix 1.Sectors selected for the study

N.	Sectors
1	Agriculture, forestry and fisheries
2	Extractive
3	Production of food, beverages and cigarettes
4	Production of textile products, apparels and leather goods
5	Production of petroleum products and gas
6	Production of chemical products
7	Production of non-metallic mineral products
8	Manufacturing and processing metals and metal products
9	Manufacturing equipment and machinery
11	Other manufacturing industries
11	Production and distribution of electricity, gas, hot water, steam and air conditioning
12	Water supply; Waste and waste water management and treatment
13	Construction
14	Transportation of warehouses
15	Trading, retail; hotel and restaurant
16	Information and communication
17	Financial, banking and insurance operations
18	Professional, scientific and technological activities
19	Education
20	Health Service
21	Other service industries

Source: Selected by authors