Analyzing the Gross Output Change of Energy Sector Industry in Indonesia between 1990 and 2005 by Decomposition Analysis

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Abstract

In recent years, contribution of energy on human life is very significant. Almost every aspect of human life needs energy. The ultimate purpose of this study is to analyze the change of gross output of energy sector industries, or it can be said energy related industries, in Indonesia from 1990 through 2005 based on the Input-Output tables to deal with the above structural changes explicitly. The structure changes analysis of the input-output tables, known as the "decomposition analysis", is used in this study. The results show that the Indonesia energy related industry which has the highest change in gross output from 1990 through 1995 is electricity and gas industry while this between 1995 and 2005 is crude oil industry. Decomposition factors which have positive influence to the Indonesia energy related industries from 1990 through 1995 are DD2, DD3, DD4, and EE while these between 1995 and 2005 are DD2, DD3, DD4, EE, and IO. In the other hand, decomposition factors which have negative influence to the Indonesia energy related industries from 1990 through 1995 are IS and IO while this between 1995 and 2005 is IS. The international comparison analysis between Indonesia and Japan suggests that the pattern of gross output change and value of decomposition factors of energy related industries between Indonesia and Japan are different. Indonesia shows more stable and positive pattern than those of Japan on gross output change and value of decomposition factors of energy related industries. The difference happened might be caused by availability of natural sources in one country and different focus of government on economic activity.

Keywords: Energy related industries, decomposition analysis, Indonesia, international comparison

I. Introduction

In recent years, contribution of energy on human life is very significant. Almost every aspect of human life needs energy. For instance, energy is needed in order to operate transportation vehicles. Energy is also needed in daily activity of human life, such as working and entertainment. Therefore, it can be said that energy can not be separated with human life.

Besides of human, energy is also consumed by industry. They use energy in operating their businesses activity. Industry is a prime component in consuming energy and its pattern of energy consumption has a great bearing on the energy balance of an economy (Liu, 2006). The examples of industry which consuming energy when operating business activity are Information and Communications Technology, or it can be abbreviated ICT, automotive, and manufacture industries.

Previous explanation shows to us about the importance of energy. It also implicitly shows to us about the importance of energy sector industry, as producer and supplier of energy. Therefore, it can be said that the study in investigating energy sector industry is important, as important as study on energy itself. This study is conducted to fulfill that need.

The ultimate purpose of this study is to analyze the change of gross output of energy sector industries, or it can be said energy related industries, in Indonesia from 1990 through 2005 based on the Input-Output tables to deal with the above structural changes explicitly. The structure changes analysis of the input-output tables, known as the "decomposition analysis", is used in this study. Four factors are used in applying this method, which is designed to decompose the changes in production of industry. Those are (1) domestic final demand expansion, or it can be abbreviated DD, (2) export expansion, or it can be abbreviated EE, (3) import substitution, or it can be abbreviated IS, and (4) technical coefficient changes, or it can be abbreviated IO. Those factors are used into the input-output tables of Indonesia on 1990, 1995, and 2005.

II. Literature Review

2.1 Energy Sector

This section discusses about energy sector. Energy sector is a category of stocks that relate to producing or supplying energy. This sector includes companies involved in the exploration and development of oil or gas reserves, oil and gas drilling, or integrated power firms (Anonymous, 2011). Energy sector or energy related industries consist of coal, iron-steel, gas, oil, etc. Indonesia energy related industries discussed in this study can be seen in table 1.

2.2 Decomposition Analysis

This section discusses about the decomposition analysis, known as Structural Decomposition Analysis (SDA), one tool in input-output analysis which can be used when analyzing the data in input-output table. According to Shikanwita, Tuhin and Debesh (2004), the definition of structural decomposition analysis is a tool which decomposes the output changes over time into some factors to quantify the underlying sources of the changes. They used structural decomposition analysis in order to investigate the sources of growth of the Indian information sector during the period 1983 – 1984 to 1993 – 1994 with 1989 – 1990. Akita & Chu (2008) used this method in order to determine the sources of output growth in Vietnam during 1996 – 2000 and conducted a comparative analysis on Vietnam from 1996 – 2000, Indonesia from 1990 – 1995 and Malaysia from 1987 – 1991.

III. Methodology

The data used in this study is input-output tables of Indonesia for 1990, 1995, and 2005 which are available for Indonesia.

Survey data is also used in this study. In this study interview with experts is done to get that data. The other purpose of conducting interview, besides of getting survey data and information related to this study, is to get the proper argument in using data in this study, especially for 2005 input-output table of Indonesia.

Before applying decomposition analysis, the industry sectors are aggregated into 159 sectors for the sake of compatibility among different periods. The Indonesia 1990 and 1995 tables consist of 161 and 172 sectors while 2005 table consists of 175 sectors. In this study, those tables are transformed or aggregated into 159 sectors. The energy sectors used in this study, from those sectors, can be seen in table 1.

We then calculate those according to the decomposition method. That method can be written in following equation:

$$X = AX + D + E - M \quad (1)$$

where X, D, E, and M are vectors of gross output, domestic final demand, exports, and imports, respectively. A is a matrix of technical coefficients. If we let $M = \hat{m}(AX + D)$, where $\hat{m}$ is a diagonal matrix of import ratios, $\hat{p} = I - \hat{m}$, where $\hat{p}$ is a diagonal matrix of domestic supply ratios, and $B = (I - \hat{p}A)^{-1}$, where B is termed the domestic Leontief inverse, then equation (1) can be modified as

$$X = B(\hat{p}D + E) \quad (2)$$

In order to solve for the change in gross outputs, $\Delta X = X_t - X_0$, equation (2) can be written as

$$\Delta X = B_t[\hat{p}_t \Delta D + \Delta E + \Delta \hat{p}(A_0 X_0 + D_0) + \hat{p}_t \Delta A X_0] \quad (3)$$

We can rewrite equation (3) as

$$\Delta X = DD + EE + IS + IO \quad (4)$$

where ΔX, DD, EE, IS, and IO are the change in gross outputs, effect of the expansion of domestic final demand, effect of export expansion, effect of the changes in import ratios (domestic supply ratios) or import substitution, and effect of the changes in technical coefficient, respectively (Akita & Chu, 2008). From DD, EE, IS, and IO the influence of expansion of domestic final demand, export expansion, the changes in import ratios (domestic supply ratios) or import substitution, and also the changes in technical coefficient to the change in gross outputs can be determined. Since the domestic final demand, D, consists of outside households, private expenditure, governmental expenditure and stock changes, the effects derived by the domestic final demand can be also disaggregated. Accordingly, the expansion of domestic final demand can be decomposed into four factors. Those are (1) household consumption expenditure, or it can be abbreviated DD1, (2) consumption expenditure of private, or it can be abbreviated DD2, (3) government consumption expenditure, or it can be abbreviated DD3, and (4) capital formation and changes in inventory, or it can be abbreviated DD4. After calculating the data, the analysis of data is done. The period time of analysis in this study divided into the two parts. First one is period from 1990 through 1995, called first period. Second one is period from 1995 through 2005, called second period. The international comparison on energy related industries is also discussed in this study. In this study, that comparison compares Indonesia and Japan energy related industries.

IV. Result and Analysis

4.1 Calculation Result and Analysis of Indonesia Energy Related Industries

Table 2 shows the change of gross output on Indonesia energy related industries from 1990 through 1995 or at first period. From table 2 can be seen that the electricity and gas industry has the highest change in gross output from 1990 through 1995. In other words, Indonesia energy related industry which has the highest development at first period is electricity and gas industry. From table 2 also can be seen that almost all of Indonesia energy related industries have positive gross output change at first period. In other words, majority of Indonesia energy related industries have positive development at first period. The industry which has negative gross output change or decrease development at first period is bauxite ore industry.

The three Indonesia energy related industries which have the highest increase on development from 1990 through 1995 are electricity and gas, basic chemical except fertilizer, and basic iron and steel products industry. This phenomenon indicates that, at first period, the trade of those industries on Indonesia is in good condition. In the other hand, three Indonesia energy related industries which have the lowest increase on development from 1990 through 1995 are nickel ore, tin ore, and bauxite ore industry. This phenomenon indicates that, at first period, the trade of those industries on Indonesia is not in good condition.

Table 3 shows the change of gross output on Indonesia energy related industries from 1995 through 2005 or at second period. From table 3 can be seen that the crude oil industry has the highest change in gross output from 1995 through 2005. In other words, Indonesia energy related industry which has the highest development at second period is crude oil industry. The industry which has the lowest gross output change at second period is bauxite ore industry. From table 3 also can be seen that all of Indonesia energy related industries have positive gross output change at second period. In other words, all of Indonesia energy related industries have positive development at second period. This phenomenon indicates that energy related industries of Indonesia are generally in good condition at second period.

Table 1 Indonesia Energy Related Industries

No.	Energy Related Industry
1	Coal
2	Crude Oil
3	Natural Gas and Geothermal
4	Tin Ore
5	Nickel Ore
6	Bauxite Ore
7	Copper Ore
8	Gold and Silver Ore
9	Other Mining
10	Basic Chemical Except Fertilizer
11	Other Chemical Products
12	Petroleum Refineries Products
13	Liquefied of Natural Gas
14	Other Non-Ferrous Products
15	Basic Iron and Steel
16	Basic Iron and Steel Products
17	Non-Ferrous Basic Metal
18	Non-Ferrous Basic Metal Products
19	Structural Metal Products
20	Other Metal Products
21	Electricity and Gas

The three Indonesia energy related industries which have the highest increase on development from 1995 through 2005 are crude oil, petroleum refineries products, and liquefied of natural gas industry. This phenomenon indicates that, at second period, the trade of those industries on Indonesia is in good condition. In the other hand, three Indonesia energy related industries which have the lowest increase on development from 1995 through 2005 are other mining, nickel ore, and bauxite ore industry. This phenomenon indicates that, at second period, the trade of those industries on Indonesia is not in good condition.

From table 2 and 3 one can see that, at the first and the second periods, Indonesia energy related industry which shows the lowest gross output change is the bauxite ore industry. This phenomenon indicates that the trade of bauxite ore industry on Indonesia from 1990 through 2005 is not in good condition. Nonetheless, positive trend of gross output change on that industry occurred from 1990 through 2005. This indicates that the improvement appeared on bauxite ore industry from first period to second period.

These two tables also show us that all of the Indonesia energy related industries have increasing trend on value of gross output change from 1990 through 2005. In other words, the difference of value of gross output change of Indonesia energy related industries, between second period and first period, is positive. This phenomenon suggests that the productivity improvement appears on all of Indonesia energy related industries between 1990 and 1995.

Table 4 shows the values of decomposition factors in Indonesia energy related industries from 1990 through 2005. The effect of expansion of domestic final demand, DD, is divided into the four factors. Those are (1) household consumption expenditure, or it can be abbreviated DD1, (2) consumption expenditure of private, or it can be abbreviated DD2, (3) government consumption expenditure, or it can be abbreviated DD3, and (4) capital formation and changes in inventory, or it can be abbreviated DD4.

Table 2 Change of Gross Output on Indonesia Energy Related Industries from 1990 through 1995

Energy Related Industry	Change of Gross Output (100 Million Rupiahs)
Electricity and Gas	62091.91
Basic Chemical Except Fertilizer	61411.41
Basic Iron and Steel Products	56331.06
Petroleum Refineries Products	55133.62
Copper Ore	29433.50
Other Metal Products	27276.04
Crude Oil	26408.23
Natural Gas and Geothermal	25093.99
Coal	24094.64
Other Non-Ferrous Products	22463.24
Other Chemical Products	19902.36
Non-Ferrous Basic Metal	18605.53
Liquefied of Natural Gas	14944.25
Gold and Silver Ore	12289.71
Structural Metal Products	6011.03
Non-Ferrous Basic Metal Products	4779.74
Basic Iron and Steel	4460.58
Other Mining	2409.30
Nickel Ore	2318.85
Tin Ore	1223.85
Bauxite Ore	-44.07

Table 3 Change of Gross Output on Indonesia Energy Related Industries from 1995 through 2005

Energy Related Industry	Change of Gross Output (100 Million Rupiahs)
Crude Oil	1396709.27
Petroleum Refineries Products	1309555.45
Liquefied of Natural Gas	760202.00
Electricity and Gas	698520.43
Coal	499045.83
Copper Ore	464252.46
Natural Gas and Geothermal	433468.33
Basic Chemical Except Fertilizer	387453.31
Other Metal Products	343730.17
Non-Ferrous Basic Metal	309309.14
Structural Metal Products	225353.23
Gold and Silver Ore	223906.90
Basic Iron and Steel Products	125707.66
Other Non-Ferrous Products	119563.43
Basic Iron and Steel	100838.70
Other Chemical Products	88713.51
Non-Ferrous Basic Metal Products	71632.57
Tin Ore	68598.38
Other Mining	18355.68
Nickel Ore	16350.37
Bauxite Ore	1781.69

Table 4 shows that the factors which show positive values in the first period are DD2, DD3, DD4, and EE. Accordingly, factors which show positive influence to the Indonesia energy related industries from 1990 to 1995 are DD2, DD3, DD4, and EE while the factors which indicate negative value at the first period are IS and IO.

Table 4 also shows that the factors which show positive values in the second period are DD2, DD3, DD4, EE, and also IO. Accordingly, the factors which have positive influence to the Indonesia energy related industries from 1995 to 2005 are DD2, DD3, DD4, EE, and IO while the factor which has negative value in the second period is IS.

The value of IO, technical coefficient changes, has substantially increased after 1995. The same phenomenon also can be seen in DD2, DD3, DD4, and EE, the consumption expenditure of private, government consumption expenditure, capital formation and changes in inventory, and export expansion, respectively. This phenomenon suggests that the role of those factors increase at second period. In other words, the role of those factors has become more significant in Indonesia energy related industries after 1995. Especially for IO, this factor has negative value at the first period while it becomes positive at the second period. This phenomenon indicates that the role of IO in Indonesia energy related industries has changed from less significant in the first period to substantially significant in the second period. This happened on EE through the periods. It is also suggested that the Indonesia government focuses on export activity on energy sector as improving their energy related industries.

The value of IS, import substitution, is negative, both in the first period and the second period. Moreover, that factor value has substantially decreases after 1995. This phenomenon indicates that the role of this factor is not significant in Indonesia energy related industries, in both the first and the second period. This phenomenon also suggests that the Indonesia government did not focus on the import activity on energy sector.

Table 4 Value of Decomposition Factors in Indonesia Energy Related Industries from 1990 through 2005

1990-1995		1995-2005	
Factor	Value (100 Million Rupiahs)	Factor	Value (100 Million Rupiahs)
DD1	0	DD1	0
DD2	374500.28	DD2	3453195.05
DD3	8820.67	DD3	329909.03
DD4	301697.09	DD4	3027371.03
EE	263766.45	EE	6008557.74
IS	-408805.53	IS	-5428278.81
IO	-63340.20	IO	272294.44

4.2 International Comparison

The international comparison on energy related industries is also discussed in this study. This study compares Indonesia with Japan for the energy related industries since these two countries represent the developing and the developed country in Asia. The period time used in this study for analysis of Japan energy related industries is from 1995 through 2005. That period time is divided into the two parts. The first one is period from 1995 through 2000. The second one is period from 2000 through 2005. Japan energy related industries used in this study are exhibited in table 5.

Table 6 shows the change of gross output on Japan energy related industries from 1995 through 2000. Table 6 shows that the petroleum refinery products industry has the highest change in gross output from 1995 through 2000 which suggests that Japan energy related industry which shows the highest development from 1995 through 2000 is petroleum refinery products industry. From table 6 it can also be seen that only three Japan energy related industries which have positive gross output change from 1995 through 2000. Those are (1) petroleum refinery products, (2) final chemical products, n.e.c., and (3) non-ferrous metals industry. This result indicates that between 1995 and 2000, in general, the trade condition of Japan energy related industries is not good. This phenomenon also indicates that the majority of Japan energy related industries have negative development from 1995 through 2000. The Japan energy industries which show negative gross output changes or decreasing development from 1995 through 2000 are metallic ores, coal products, non-ferrous metal products, non-metallic ores, coal mining & crude petroleum and natural gas, pig iron and crude steel, metal products for construction and architecture, cast and forged steel products & other iron or steel products, other metal products, and steel products.

Table 5 Japan Energy Related Industries

No.	Energy Related Industry
1	Metallic ores
2	Non-metallic ores
3	Coal mining & Crude petroleum and natural gas
4	Final chemical products, n.e.c.
5	Petroleum refinery products
6	Coal products
7	Pig iron and crude steel
8	Steel products
9	Cast and forged steel products & Other iron or steel products
10	Non-ferrous metals
11	Non-ferrous metal products
12	Metal products for construction and architecture
13	Other metal products

Table 7 shows the changes of the gross outputs of the Japan energy related industries from 2000 through 2005. Table 7 shows that the steel products industry has the highest change in gross output from 2000 through 2005, suggesting that the Japan energy related industry which has the highest development from 2000 through 2005 is the steel products industry. Table 7 also shows that only two Japan energy related industries which has negative gross output changes from 2000 to 2005. Those are (1) final chemical products, n.e.c., and (2) non-metallic ores industry. These suggest that, in general, the trade condition of Japan energy related industries is good between 2000 and 2005. This also indicates that the majority of Japan energy related industries have positive development from 2000 through 2005.

Table 8 shows the value of decomposition factors in Japan energy related industries from 1995 through 2005. From table 8 it can be seen that from 1995 to 2000 the factors which show positive value are DD2, DD3, and EE. Accordingly, factors which have positive influence to the Japan energy related industries from 1995 through 2000 are DD2, DD3, and EE while those with negative value from 1995 through 2000 are DD1, DD4, IS and IO. This phenomenon indicates that factors with negative influence to the Japan energy related industries from 1995 through 2000 are DD1, DD4, IS and IO.

Table 8 suggests that the factors which have positive value from 2000 through 2005 are DD2, DD3, EE, and IO. Accordingly, factors which have positive influence to the Japan energy related industries from 2000 through 2005 are DD2, DD3, EE, and IO while the factors which have negative value from 2000 through 2005 are DD1, DD4, and IS. The value of IS, import substitution, from 1995 through 2005 is negative suggesting that the role of that factor is not significant in Japan energy related industries from 1995 through 2005.

The above international comparison analysis suggests that the pattern of gross output change and value of decomposition factors of energy related industries between Indonesia and Japan are different. Indonesia shows more stable and positive pattern than those of Japan on gross output change and value of decomposition factors of energy related industries. The difference happened might be caused by availability of natural sources in one country and different focus of government on economic activity. In addition, the summary of international comparison on energy related industries between Indonesia and Japan can be seen in table 9.

Table 6 Change of Gross Output on Japan Energy Related Industries from 1995 through 2000

Energy Related Industry	Change of Gross Output (100 Million Yen)
Petroleum refinery products	28624.93
Final chemical products, n.e.c.	1797.73
Non-ferrous metals	581.71
Metallic ores	-6.91
Coal products	-307.33
Non-ferrous metal products	-320.15
Non-metallic ores	-383.07
Coal mining & Crude petroleum and natural gas	-426.00
Pig iron and crude steel	-3822.91
Metal products for construction and architecture	-3823.65
Cast and forged steel products & Other iron or steel products	-4906.89
Other metal products	-8548.88
Steel products	-12606.29

Table 7 Change of Gross Output on Japan Energy Related Industries from 2000 through 2005

Energy Related Industry	Change of Gross Output (100 Million Yen)
Steel products	53697.28
Petroleum refinery products	42686.45
Pig iron and crude steel	35826.23
Non-ferrous metals	8176.89
Non-ferrous metal products	7079.21
Cast and forged steel products & Other iron or steel products	6858.33
Coal products	2680.44
Metal products for construction and architecture	2132.08
Other metal products	395.11
Metallic ores	85.17
Coal mining & Crude petroleum and natural gas	26.20
Final chemical products, n.e.c.	-854.31
Non-metallic ores	-1649.45

Table 8 Value of Decomposition Factors in Japan Energy Related Industries from 1995 through 2005

1995-2000		2000-2005	
Factor	Value (100 Million Yen)	Factor	Value (100 Million Yen)
DD1	-271.11	DD1	-377.88
DD2	6664.01	DD2	9645.55
DD3	5091.37	DD3	1928.63
DD4	-4793.31	DD4	-527.82
EE	21132.69	EE	65510.96
IS	-15613.32	IS	-33371.75
IO	-16358.05	IO	114331.96

Table 9 Summary of International Comparison on Energy Related Industries between Indonesia and Japan

Compared Matter	Indonesia		Japan	
	1990 - 1995	1995 - 2005	1995 - 2000	2000 - 2005
Energy related industry which has the highest gross output change	Electricity and gas	Crude oil	Petroleum refinery products	Steel products
Energy related industry which has the lowest gross output change	Bauxite ore	Bauxite ore	Steel products	Non-metallic ores
The amount of energy related industry which has positive gross output change (percentage)	95%	100%	23%	85%
The amount of energy related industry which has negative gross output change (percentage)	5%	0%	77%	15%
Positive decomposition factor(s)	DD2, DD3, DD4, EE	DD2, DD3, DD4, EE, IO	DD2, DD3, EE	DD2, DD3, EE, IO
Negative decomposition factor(s)	IS, IO	IS	DD1, DD4, IS, IO	DD1, DD4, IS
GDP, 2000 (in million constant 1995 US dollars)	209,098		5,687,635	
Average annual growth in GDP, 1991 - 2000 (Total)	4%		1%	

V. Conclusion and Future Research

The results show that the Indonesia energy related industry which has the highest change in gross output from 1990 through 1995 is electricity and gas industry while this between 1995 and 2005 is crude oil industry. Decomposition factors which have positive influence to the Indonesia energy related industries from 1990 through 1995 are DD2, DD3, DD4, and EE while these between 1995 and 2005 are DD2, DD3, DD4, EE, and IO. In the other hand, decomposition factors which have negative influence to the Indonesia energy related industries from 1990 through 1995 are IS and IO while this between 1995 and 2005 is IS.

From the international comparison analysis between Indonesia and Japan can be seen that, in general, the pattern of gross output change and value of decomposition factors of energy related industries between Indonesia and Japan are different. Indonesia shows more stable and positive pattern than Japan on gross output change and value of decomposition factors of energy related industries. The difference happened might be caused by availability of natural sources in one country and different focus of government on economic activity.

The future researches suggested from this study are (1) to consider other countries, as international comparison, in analyzing energy related industries on Asia developed and developing countries, such as Korea, China, India, Malaysia, and Thailand, and (2) to consider influence of other factors, such as global market aspects, foreign exchange rates, and financial flow, in analyzing energy related industries of countries, especially on Asia developed and developing countries. The deeper analysis in energy related industries of Asia developed and developing countries is expected to appear from those future researches. Moreover, the deeper comprehension on Input-Output analysis, especially on decomposition analysis, is also expected to appear from those future researches.

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