An application of input-output analysis in analyzing the impacts of final demands changes on the total outputs of Japanese energy sectors: A further study

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Abstract. The purpose of this study is to continue the previous study which discussed the impacts of final demands changes on the total outputs of Japanese energy sectors. More specifically, this study aims to conduct a deeper analysis regarding these impacts. This study employs a demand-pull Input-Output (IO) quantity model, one of the calculation instruments in IO analysis, as a tool of analysis. This study focuses on two sectors, namely (1) petroleum refinery products, and (2) non-ferrous metals. Two conditions are considered in the analysis part, namely (1) “whole sector change”, and (2) “pure change”. The results show that in both conditions, both discussed sectors have similar patterns. The results also explain that, in both conditions, the biggest positive impact for the sector of petroleum refinery products is given by scenario 4, the modification of consumption expenditures of private.

1. Introduction
In this day and age, human dependence on energy can be easily observed. The simplest evidence is human needs energy when he or she does the activities. This dependency can also be seen in broader aspects. For example, the government usually considers the availability of energy sources when new economic policies must be made. Besides, countries also consider this availability before executing the economic activities such as an international trade. Therefore, based on these facts, one can argue that energy is also economically important.

Many previous studies discussed the energy topic. For example, [1] described the connections between the prices of oil and Euro area’s inflation. [2] investigated the effect of oil price shocks on the economic growth of some Middle East and North Africa (MENA) countries. [3] analyzed the relationship between the changes of price of oil and real Gross Domestic Product (GDP) which the focus was the economy of US. Besides, [4] analyzed the ways to increase the total outputs of Japanese energy sectors in the future. He used Input-Output (IO) analysis and some scenarios of final demands change in his study.

The study analyzes the impacts of final demands changes on the total outputs of energy sectors of specific country, viewed from above previous studies, however, is still thin. This analysis is important because it will describe the characteristics of these sectors when the changes of national economy condition happen. Further, it can give the understanding regarding the improvements needed for enhancing the sectors. This study is conducted in order to fulfill the gap.

The purpose of this study is to continue the previous study which discussed the impacts of final demands changes on the total outputs of Japanese energy sectors. More specifically, this study aims to conduct a deeper analysis regarding these impacts. This study employs IO approach as a tool of analysis.
2. Methodology

The methodology of this study is similar with the one used in a previous study, the study conducted by [4], and described as follows. The first step is to explain the data used. This study uses an aggregated IO table of Japan for 2005. This table consists of 89 industrial sectors. These industries are described in Appendix.

The second step is to describe Japanese energy sectors used. Table 1 shows these sectors. As with a previous study, this study also focuses on two sectors. These sectors are (1) petroleum refinery products, and (2) non-ferrous metals.

The third step is to conduct the calculation in order to know the impacts of final demand changes on the total outputs of analyzed sectors. A demand-pull IO quantity model, one of the calculation instruments in IO analysis, is used in this calculation. [5] explained that following equation is a representation of this model:

\[ x^1 = L^0 f^1 \]  

where \( x \), \( L \), and \( f \) are matrices of total outputs of sectors, Leontief inverse, and final demands of sectors, respectively. \( 0 \) and \( 1 \) describe initial and future periods, respectively. An initial period in this study is 2005. Table 2 explains the scenarios of final demands modification used. These scenarios, compared with previous ones, are slightly different. The difference can be seen on the existence of scenario 4, the change of consumption expenditures of private. Simultaneously, the deeper understanding regarding the impacts is obtained through this extension.

The conditions of “whole sector change” and “pure change” are considered in above calculation. The former situation explains the condition which the changes of final demands are addressed to all Japanese industrial sectors while the latter one only focuses on the discussed sectors. In this study, the former one will be called “condition A” while the term of “condition B” is used to explain the latter condition. The analysis regarding above impacts is discussed on the next step. Conclusions of this study and suggestions for further researches are described on the final step.

| No. | Sector Number | Sector Name                                      |
|-----|---------------|-------------------------------------------------|
| 1   | 6             | Metallic ores                                   |
| 2   | 7             | Non-metallic ores                               |
| 3   | 8             | Coal mining, crude petroleum and natural gas     |
| 4   | 26            | Final chemical products, n.e.c.\(^a\)           |
| 5   | 27            | Petroleum refinery products                      |
| 6   | 28            | Coal products                                   |
| 7   | 36            | Pig iron and crude steel                        |
| 8   | 37            | Steel products                                  |
| 9   | 38            | Steel castings and forgings, and other steel products |
| 10  | 39            | Non-ferrous metals                              |
| 11  | 40            | Non-ferrous metal products                      |
| 12  | 41            | Metal products for construction and architecture |
| 13  | 42            | Other metal products                            |

\(^a\)Not elsewhere classified.

(Source: [6] with slight modifications)
Table 2. The scenarios of final demands modification used in this study.

| Component of Final Demand | Scenario 1 | Scenario 2 | Scenario 3 | Scenario 4 |
|---------------------------|------------|------------|------------|------------|
|                           | Exports Modification | Imports Modification | The Modification of Consumption Expenditures of Outside Households | The Modification of Consumption Expenditures of Private |
| Exports                   | Increase 30% | Constant   | Constant   | Constant   |
| Imports                   | Constant   | Increase 30% | Constant   | Constant   |
| Consumption expenditures of outside households | Constant | Constant | Increase 30% | Constant |
| Consumption expenditures of private         | Constant | Constant | Constant | Increase 30% |

3. Results and analysis

Table 3 describes the total outputs of discussed sectors for each scenario on condition A. Figures 1 and 2 explain in more details the dynamics happen on these total outputs on this condition. Based on these results, one can argue that, on this condition, the biggest positive impact on the total output of petroleum refinery products sector is given by scenario 4, the modification of consumption expenditures of private. Meanwhile, scenario 1, the exports modification, has the biggest positive effect on the total output of non-ferrous metals sector. On the contrary, the negative impact is given by scenario 2, the change of imports.

On the other hand, Table 4 describes the total outputs of analyzed sectors for each scenario on condition B. Figures 3 and 4 explain in more details the dynamics happen on these total outputs on this condition. Based on these results, one can say that, on this condition, the biggest positive impact on the total output of petroleum refinery products sector is given by scenario 4, the modification of consumption expenditures of private. Meanwhile, scenario 1, the change of exports, has the biggest positive effect on the total output of non-ferrous metals sector. On the contrary, the negative impact is given by scenario 2, the imports change.

Above phenomena show that, in both conditions, both discussed sectors have similar patterns, namely these industries receive the positive impacts from scenarios 1, 3, and 4 while the opposite impact is obtained from scenario 2. This negative impact also appeared in the previous study. Above phenomena also explain that, in both conditions, the biggest positive impact for the sector of petroleum refinery products is given by scenario 4, the modification of consumption expenditures of private. This is a new finding compared with a previous study. Based on these results, one can argue that the effective ways to increase the total output of this sector in the future are to open greater opportunities for private sectors in processing products of this industry, and to restrict import activities regarding these products.

Table 3. Total outputs of discussed sectors for each scenario on condition A (100 million Yen).

| Sector Number | Sector Name                  | \( X_t \) | \( X_{t+1} \), Scenario 1 | \( X_{t+1} \), Scenario 2 | \( X_{t+1} \), Scenario 3 | \( X_{t+1} \), Scenario 4 |
|---------------|------------------------------|--------|---------------------|---------------------|---------------------|---------------------|
| 27            | Petroleum refinery products  | 156,740.17 | 170,203.33 | 138,594.26 | 158,126.05 | 193,243.18 |
| 39            | Non-ferrous metals           | 21,527.12  | 29,139.76  | 11,014.71  | 21,820.99  | 24,959.84  |
Figure 1. The dynamics happen on the total output of petroleum refinery products sector (condition A).

Figure 2. The dynamics happen on the total output of non-ferrous metals sector (condition A).
Table 4. Total outputs of discussed sectors for each scenario on condition B (100 million Yen).

| Sector Number | Sector Name                | \( X_t \) | \( X_{t+1} \), Scenario 1 | \( X_{t+1} \), Scenario 2 | \( X_{t+1} \), Scenario 3 | \( X_{t+1} \), Scenario 4 |
|---------------|---------------------------|-----------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
| 27            | Petroleum refinery products | 156,740.17 | 159,467.79                  | 148,055.30                  | 156,843.72                  | 175,229.98                  |
| 39            | Non-ferrous metals         | 21,527.12  | 22,943.73                   | 14,992.47                   | 21,527.36                   | 21,896.06                   |

Figure 3. The dynamics happen on the total output of petroleum refinery products sector (condition B).

Figure 4. The dynamics happen on the total output of non-ferrous metals sector (condition B).
4. Conclusions and further researches

This study, as a continuation of a previous study, conducted the deeper analysis regarding the impacts of final demands changes on the total outputs of Japanese energy sectors. This study employed a demand-pull IO quantity model, one of the calculation instruments in IO analysis, as a tool of analysis. This study focused on two sectors, namely (1) petroleum refinery products, and (2) non-ferrous metals. Two conditions were considered in the analysis part, namely (1) “whole sector change”, and (2) “pure change”. An initial period in this study was 2005. The difference between current and previous studies could be seen on the existence of scenario 4, the change of consumption expenditures of private.

The results showed that in both conditions, both discussed sectors had similar patterns, namely these industries obtained the positive impacts from scenarios 1, 3, and 4 while the opposite impact was received from scenario 2. This negative impact also appeared in the previous study. The results also explained that, in both conditions, the biggest positive impact for the sector of petroleum refinery products was given by scenario 4, the modification of consumption expenditures of private. This was a new finding in this topic. Based on these results, the suggestions from this study regarding the effective ways to increase the total output of this sector in the future were to open greater chances for private sectors in processing products of this industry, and to limit import activities regarding these products.

The deeper understanding regarding the impacts of final demands changes on the total outputs of Japanese energy sectors was obtained from this study. However, this study only analyzed specific energy sectors of Japan. In other words, the comprehensive view regarding the impacts on the national economy of Japan did not appear in this study. This view is needed in order to make comprehensive policies for enhancing the economic condition of Japan in the future. Therefore, as a further research, this study proposes the same analysis for other Japanese industrial sectors.

The other suggested further research from this study is to conduct the international comparison on the current topic. This comparison will describe the characteristics of industries of analyzed countries when the final demands changes happen. A good example is to compare developed and developing countries.

References

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Appendix. Japanese Industrial Sectors (89 Sectors)

| No. | Sector Name                                                                 |
|-----|------------------------------------------------------------------------------|
| 1   | Crop cultivation                                                             |
| 2   | Livestock                                                                    |
| 3   | Agricultural services                                                        |
| 4   | Forestry                                                                     |
| 5   | Fisheries                                                                    |
| 6   | Metallic ores                                                                |
| 7   | Non-metallic ores                                                            |
| 8   | Coal mining, crude petroleum and natural gas                                 |
| 9   | Foods                                                                        |
| 10  | Beverage                                                                     |
| 11  | Feeds and organic fertilizer, n.e.c.                                         |
| 12  | Tobacco                                                                      |
| 13  | Textile products                                                             |
| 14  | Wearing apparel and other textile products                                  |
| 15  | Timber and wooden products                                                   |
| 16  | Furniture and fixtures                                                       |
| 17  | Pulp, paper, paperboard, building paper                                      |
| 18  | Paper products                                                               |
| 19  | Printing, plate making and book binding                                      |
| 20  | Chemical fertilizer                                                          |
| 21  | Industrial inorganic chemicals                                               |
| 22  | Petrochemical basic products and intermediate chemical products             |
| 23  | Synthetic resins                                                             |
| 24  | Synthetic fibers                                                             |
| 25  | Medicaments                                                                  |
| 26  | Final chemical products, n.e.c.                                              |
| 27  | Petroleum refinery products                                                  |
| 28  | Coal products                                                                |
| 29  | Plastic products                                                             |
| 30  | Rubber products                                                              |
| 31  | Leather, fur skins and miscellaneous leather products                        |
| 32  | Glass and glass products                                                     |
| 33  | Cement and cement products                                                   |
| 34  | Pottery, china and earthenware                                               |
| 35  | Other ceramic, stone and clay products                                       |
| 36  | Pig iron and crude steel                                                     |
| 37  | Steel products                                                               |
| 38  | Steel castings and forgings, and other steel products                        |
| 39  | Non-ferrous metals                                                           |
| 40  | Non-ferrous metal products                                                   |
41 Metal products for construction and architecture
42 Other metal products
43 General industrial machinery
44 Special industrial machinery
45 Other general machines
46 Machinery for office and service industry
47 Electrical appliance
48 Motor vehicles
49 Ships and repair of ships
50 Other transportation equipment and repair of transportation equipment
51 Precision instruments
52 Miscellaneous manufacturing products
53 Building construction
54 Repair of construction
55 Civil engineering
56 Electricity
57 Gas and heat supply
58 Water supply
59 Waste management service
60 Commerce
61 Finance and insurance
62 Real estate agencies and rental services
63 House rent
64 Railway transport
65 Road transport (except transport by private cars)
66 Self-transport by private cars
67 Water transport
68 Air transport
69 Freight forwarding
70 Storage facility service
71 Services relating to transport
72 Communication
73 Broadcasting and information services
74 Public administration
75 Education
76 Research
77 Medical service and health
78 Social security
79 Other public services
80 Advertising, survey and information services
81 Goods rental and leasing services
82 Repair of motor vehicles and machine
83 Other business services
84 Amusement and recreational services
85 Eating and drinking places
|   | Category                                    |
|---|--------------------------------------------|
| 86 | Accommodations                             |
| 87 | Other personal services                     |
| 88 | Office supplies                             |
| 89 | Activities not elsewhere classified         |

(Source: [7] with slight modifications)