An input-output approach to analyze the ways to increase total output of energy sectors: The case of Japan

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Abstract. The purpose of this study is to analyze the ways to increase total output of Japanese energy sectors in future time. In this study, Input-Output (IO) analysis is employed as a tool of analysis. This study focuses on petroleum refinery products and non-ferrous metals as analyzed sectors. The results show that positive impact observed in export and outside households consumption modifications while opposite impact is given by modification of import. The recommendations suggested based on these results are Japanese government should make breakthroughs so analyzed sector’s export activities can increase and they have to careful in conducting import activities related to these sectors.

1. Introduction
Humans need energy in order to conduct their activities. This dependency will continue not only in micro but also macro aspects. For example, in micro scale, people need energy in conducting daily tasks such as work and sport. In macro scale, countries direct and indirectly need energy, represented by their energy sectors, in order to execute their economic activities such as making new workplaces and enhancing the education level of society. These arguments indicate that energy is also economically important.

There are many previous studies investigated the relationship between energy and economic aspects. [1] analyzed the relationship between changes of oil price and real Gross Domestic Product (GDP) which the focus was US economy. [2] explained the connections between Euro area’s inflation and oil prices. Besides, [3] explored the effect of oil price shocks on growth of economy of some Middle East and North Africa (MENA) countries. The study focuses on the ways to increase the amount of energy, represented by total output of energy sectors, using economic analysis, however, still lack. The kind of study, actually, is needed in order to know, from point of view of economy, the improvements should be done in enhancing the sectors. This study is conducted in order to fulfill the gap.

The purpose of this study is to analyze the ways to increase energy sector’s total output in future time. In this study, the object of study is Japan, one of developed country in the world. This study employs Input-Output (IO) analysis as a tool of analysis. More specifically, this study employs demand-pull IO quantity model in achieving the purpose.
2. Methodology

As mentioned in introduction, this study uses demand-pull IO quantity model in order to know the ways to enhance total output of Japanese energy sectors in future time. Following explanation is provided to describe the methodology of this study. The first step is to describe Japanese energy sectors used in this study. Table 1 shows these sectors. The focused energy sectors are chosen based on results of previous study. [4] explained that petroleum refinery products and non-ferrous metals sectors had positive gross output changes during 1995-2005. The positive changes in gross output of one sector indicate that this sector has positive growth in specific period. In other words, this sector gives strong impact in national economy in the period. Further, higher increase on total output of this sector will generate higher enhancement on national economy in future time. This study then follows their results, namely exposing petroleum refinery products and non-ferrous metals as analyzed sectors.

Table 1. Japanese energy sectors used in this study.

| 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.                       |
| 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                                  |

(Source: [4] with slight modifications)

The second step is to do the calculation in order to know the ways to increase total output of analyzed sectors. Demand-pull IO quantity model is used in this calculation. According to [5], following equation describes this model:

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

where \( x \), \( L \), and \( f \) are matrices of total output of industrial sectors, Leontief inverse, and final demand of industrial sectors, respectively. \( 0 \) and \( 1 \) indicate present and future periods, respectively. Above equation explains that final demand modifications will give impact to total output of sectors. In other words, the ways that are conducted in order to give impact on total output of one sector in future time can be represented by the final demand changes. Table 2 describes the scenarios of final demand modification used in this study. Modified 2005 IO table of Japan is used as a base of calculation.

“Whole sectors change” and “pure change” conditions, actually, are considered in this calculation. Former word describes the condition where modifications of final demand are addressed to all Japanese industrial sectors while latter one only focuses on analyzed sectors. In this study, former one will be called condition A while condition B is used in describing latter condition. Recommendations then suggested based on calculation results.
Table 2. The scenarios of final demand modification used in this study.

| Component of final demand | Scenario 1 | Scenario 2 | Scenario 3 |
|---------------------------|------------|------------|------------|
| Export modification       | Rises 30%  | Constant   | Constant   |
| Import modification       | Constant   | Rises 30%  | Constant   |
| Outside households        | Constant   | Constant   | Rises 30%  |
| consumption modification  |            |            |            |

(Source: [6] with slight modifications)

3. Results and discussion

Figures 1 and 2 describe total output of petroleum refinery products and non-ferrous metals sectors for each scenario in condition A, respectively. On the other hand, figures 3 and 4 expose total output of these sectors for each scenario in condition B. In this study, $t$ and $t+1$ indicate present and future times, respectively.

Based on information in the figures, for both conditions, similar patterns appear in analyzed sectors. These patterns can be described as follows. First, positive impact, represented by increasing on total output in future time, observed in scenarios 1 and 3. Second, negative impact, represented by decreasing on total output in future time, is given by import modification.

The figures also show that scenario 1 gives higher positive impact than scenario 3 in analyzed sectors. Therefore, this scenario should be prioritized by Japanese government in order to increase total output of these sectors. In other words, Japanese government should make breakthroughs so these sector’s export activities can increase. For example, improving the quality of refinery products of petroleum and making the competitive prices for these products.

Another aspect should be considered by Japanese government is import activities related to analyzed sectors. These activities, actually, give negative impact to these sectors. Therefore, they have to careful in conducting these activities. Import restriction related to products of the sectors is a good example.

4. Conclusions and further researches

The purpose of this study is to analyze the ways to increase total output of Japanese energy sectors in future time. In this study, demand-pull IO quantity model is employed as a tool of analysis. This study focuses on petroleum refinery products and non-ferrous metals as analyzed sectors. Three scenarios of final demand modification are used in the calculation of this study. These are (1) export, (2) import, and (3) Outside households consumption modifications. This study uses modified 2005 IO table of Japan as a base of calculation. “Whole sectors change” and “pure change” conditions are also considered in the calculation.

The results show that positive impact, represented by increasing on total output in future time, observed in scenarios 1 and 3 while opposite impact is given by modification of import. Besides, the results expose that scenario 1 gives higher positive impact than scenario 3 in analyzed sectors. This phenomenon appears in both conditions. The recommendations suggested based on these results are Japanese government should make breakthroughs so analyzed sector’s export activities can increase and they have to careful in conducting import activities related to these sectors. More specifically, they should (1) improve the quality of refinery products of petroleum, (2) make the competitive prices for these products, and (3) do the restriction for import activities related to the products.
Figure 1. Total output of petroleum refinery products sector for each scenario in condition A.

Figure 2. Total output of non-ferrous metals sector for each scenario in condition A.
Figure 3. Total output of petroleum refinery products sector for each scenario in condition B.

Figure 4. Total output of non-ferrous metals sector for each scenario in condition B.
This study, however, only focuses on petroleum refinery products and non-ferrous metals sectors. Other Japanese energy sectors analysis might generate different results compared with this study. Therefore, this analysis is a suggested further research from this study. Besides, this study also suggests international comparison related to this topic. This comparison will describe the characteristics of energy sectors in compared countries including the difference and/or similarity on the ways to increase total output of these sectors.

References
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