An Application of Multiplier Analysis in Analyzing the Role of Mining Sectors on Indonesian National Economy

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Abstract. This purpose of the current study aims is to analyze the multiplier analysis on mining sector in Indonesia. The mining sectors defined by coal and metal; crude oil, natural gas, and geothermal; and other mining and quarrying. The multiplier analysis based from input output analysis, this divided by income multiplier and output multiplier. This results show that (1) Indonesian mining sectors ranked 6th with contribute amount of 6.81% on national total output; (2) Based on total gross value added, this sector contribute amount of 12.13% or ranked 4th; (3) The value from income multiplier is 0.7062 and the value from output multiplier is 1.2426.

1. Introduction

The development of Indonesian economy needs to pay attention to the development of every sector in the economy. The development of the economic sector could have an impact on increasing output although it does not necessarily reflect the equitable distribution of people's income and job opportunity [1]. In fact, every country can not always develop all economic sector. Thus, a country must choice the economic sectors that it’s expected to increase income distribution and provide employment.

Early Indonesian economy, one of leading economic sector is mining sector besides agricultural sector. This sector defined as secondary sector or it’s included in industrial sector. Based on Central Bureau of Statistics data, in 1960’s, the contribution of this sector only 31.73%, then increasing until 46.78% in 2010 [2]. Based from BPS data, in 2000, the contribution of mining sector compared with other economic sectors amount of 15.60%, it’s decreasing until 13.13% in 2005; 10.46% in 2010; and last 2015’s, it’s not far from 9% [3]. The establishment of a solid structure in which the agricultural economy and mining quarrying sector, it make form the basis of an economy that produces products in both an efficient, an effective, and a modern manner, in which the manufacturing sector contains global competitiveness and becomes the engine of the Indonesia economy, and services become the glue of economic resilience [4].

Data from Indonesia’s Investment Co-ordinating Board (BKPM) suggest that foreign investment is concentrated in Java (60%) and Sumatra (21%), particularly in the Jakarta metropolitan area, Batam, Bintan and Karimun. Since 2004, FDI concentration has shifted from manufacturing toward the mining and quarrying and certain services sectors. Foreign investors tend to come from other Asian countries, with Japan, Korea, Malaysia and Singapore as important investors. However, other countries, such as
the United States (particularly in the mining sector) and the United Kingdom are also important sources of FDI in Indonesia [5].

The economic sector cannot be separated from community activities, either in the form of outward-oriented goods or services, in other words, it must be export oriented sector to other regions, otherwise the economic sector is not to be the imported sector’s, in other words, all products (goods and services) came from other regions [6,7]. The purpose of this paper is to know the role of mining sector on Indonesian economy. The role of this sector is described by the contribution on national total output and gross value added, then the value from income and output multiplier. This paper focuses on the case of the Indonesian state and uses the input output analysis approach as an analytical instrument.

2. Experimental
2.1. Data
The data sources in this paper came from Indonesia's input output data in 2008. This data published by the Central Bureau of Statistics. The use of data is expected to capture the changes occurring along this periods as well as to know the impact of a priority sector on household income. The data are classified into 10 sectors. These are agriculture, other crops, forestry and hunting; mining & quarrying sector; manufacturing industry sector; electricity gas and water supply; construction; trade, hotel and restaurant; transportation sector; communications sector; financial, ownership, & business services; and services sector.

2.2. Input Output Method
The Input-Output Table, commonly called as Table I-O, was first introduced by W. Leontief in the 1930s. Table I-O is a table that provides information about transactions of goods and services that occur between production sectors within an economy. It’s presented in the form of a matrix [8,9]. The data in table I-O shows trade relationships between sectors within a country's economy. Each line shows the number of sales from a sector. Since a sector does not sell its goods to an existing sector, it is common to find zeros in a row in table I-O. The columns in the I-O table record purchases made by a sector on goods and services produced by various sectors within the region. If the numbers within the columns of a sector are numerous zeros, this is because a sector does not always buy goods and services from all sectors in the country's economies [8,9,10]. The simplest form of the I-O table is as follows.

| Seller Sector | Buyer Sector | Final Demand | Total Production |
|---------------|--------------|--------------|------------------|
|               | 1            | 2            | ...             | n                |
| 1             | X_{11}       | X_{12}       | ...             | X_{1n}           | f_1           | X_1 |
| ...           | ...          | ...          | ...             | ...              | ...           | ... |
| N             | X_{n1}       | X_{n2}       | ...             | X_{nn}           | f_n           | X_n |
| Value Added   | V_1          | V_2          | ...             | V_n              |
| Import        | M_1          | M_2          | ...             | M_n              |
| Total Input   | X_1          | X_2          | ...             | X_n              |

From table 1, we can made two balanced balance equations:
Row:
\[
\sum_{j=1}^{n} x_{ij} + f_i = x_i; \forall i = 1,2,3,...,n
\]
(1)
Column:
\[
\sum_{i=1}^{n} x_{ij} + v_j + m_j = x_j; \forall i = 1,2,3,...,n
\]
(2)
Where $x_{ij}$ is the flow of goods and services from sector i to sector j; $F_i$ is the total final consumption; $V_j$ is value added; and $M_i$ is import. The definition of a balanced balance is the amount of production equal to the number of inputs. The flow can be transformed into coefficients by assuming that the number of purchases is fixed for a total output level and there is no possibility of substitution between an input feed and another input material. From both equations we can constructed coefficient as follows:

$$a_{ij} = x_{ij} / x_j$$ (3)

or

$$x_{ij} = a_{ij} x_j$$ (4)

with substitute equation (4) to (1), we get :

$$\sum_{j=1}^{n} a_{ij} x_{ij} + f_i = x_i; \forall i = 1, 2, 3, ..., n$$ (5)

From equation (2.5), we have basic relationship in IO Table as follows :

$$(I - A)^{-1} f = x$$ (6)

Notation $(I - A)^{-1} f = x$; it’s named as Leontief’s inverse matrix. This matrix provides important information on how increased production of a sector will lead to the development of other sectors. Because each sector has a different pattern, then the impact of a sector’s production changes on the total production of other sectors will be different. The Leontief matrix summarizes the entire impact of a sector’s production change on the total production of another sector into a coefficient. It’s often known as multipliers.

Since the purpose of this paper is to calculate the impact of the mining sector on output, it is necessary to know the value of the output multiplier which is the amount of output created by the increased demand for sector j output by 1 unit. The output multiplier calculation formula as follows:

$$W_j = \sum_{i=1}^{n} V_{ij} \Phi_i$$ (7)

Where $W_j$ is the output multiplier sector j; $v_{ij}$ is Leontief’s inverse matrix; and $\Phi_i$ is the output coefficient.

Second, the purpose of this paper is to calculate the impact of the mining sector on household income, it is necessary to know the value of the income multiplier which is the amount of income created by the increased demand for sector j output by 1 unit. The income multiplier calculation formula as follows:

$$H_j = \sum_{i=1}^{n} v_{ij} \Pi_i$$ (8)

Where $H_j$ is the income multiplier sector j; $v_{ij}$ is Leontief’s inverse matrix; and $\Pi_i$ is the income coefficient. The income coefficient can be calculated by dividing the total revenue of sector i by output from sector i.

3. Results And Discussions

| No | Sector                          | Output       | Percentage |
|----|--------------------------------|--------------|------------|
| 1  | Manufacturing                   | 3,882,504,357| 36.87%     |
| 2  | Trade, hotel, & restaurant      | 1,336,221,986| 12.69%     |
| 3  | Construction                    | 1,243,975,535| 11.81%     |
| 4  | Agriculture                     | 1,098,336,352| 10.43%     |
| 5  | Public administration            | 900,298,190  | 8.55%      |
| 6  | Mining                          | 717,482,885  | 6.81%      |
| 7  | Finance                         | 566,629,564  | 5.38%      |
| 8  | Transportation                  | 469,459,527  | 4.46%      |
| 9  | Communication                   | 190,642,096  | 1.81%      |
| 10 | Electricity, gas, and water supply| 124,490,705  | 1.18%      |

Based on table 2, it shows that the manufacturing industry sector has the highest value followed by the trade, hotel, and restaurant sector. While the sector with the lowest value is the electricity, gas, and water supply sector. The value of contribution on total output is 36.87% for the manufacturing industry, this value indicates that it has a strong ability to drive output growth. Not only this sector, but also other
sector likes trade, hotel, & restaurant sector; construction sector; and agricultural sector can be a leading sector to drive output growth too. As we know that the output generated from these sectors is the intermediate output, then the output can be a raw material for industry or other economic sectors.

| No  | Sector                           | Value Added   | Percentage |
|-----|----------------------------------|---------------|------------|
| 1   | Agriculture                      | 1,399,524,198 | 15.94%     |
| 2   | Mining                           | 1,065,408,831 | 12.13%     |
| 3   | Manufacturing industry           | 2,468,458,179 | 28.11%     |
| 4   | Electricity, gas, and water supply| 60,499,186    | 0.69%      |
| 5   | Construction                     | 735,427,477   | 8.37%      |
| 6   | Trade, hotel, and restaurant     | 1,166,246,423 | 13.28%     |
| 7   | Transportation                   | 296,926,731   | 3.38%      |
| 8   | Communication                    | 267,757,988   | 3.05%      |
| 9   | Finance                          | 684,665,646   | 7.80%      |
| 10  | Public administration            | 637,498,651   | 7.26%      |

Next, from Table 3, the contribution of value added, it can be seen that the manufacturing industry sectors have the highest value, then followed by the agriculture sector. While the sector with the lowest value is the electricity, gas, and water supply sector. The value is 28.11% for the manufacturing sector and 15.94% for the agriculture sector. This value indicates that the sector has a strong ability to encourage the growth of the downstream and the upstream sector, because as each increase in one unit to the final demand will encourage an increase in output for this sector if it’s used as an input. Then, if we show the total contribution of two biggest sectors, both manufacturing industry sector and agriculture sector have 45% on total value added. So, both sectors can be the priority economic sectors. The development of this sectors of the economy in the long run is expected to encourage the growth of other sectors, to reduce poverty, and it is expected to create sustainable growth in economy.

As we know that the mining sector has been one of the key sectors supporting Indonesian economic for many decades. Not only have a significant contribution to Indonesian Gross Domestic Product, but also the mining sector make a significant contribution to Indonesian exports, government revenue, employment, and the development of many remote regions. The development of many remote regions become exist because mining companies are located in remote regions where it gives significant employers. Eventhough this sector is still remains a significant contributor to the Indonesian economy, this contribution tend to decrease. If we compare with two period, in 2011, the contribution to GDP equal to 6.14%; then in 2016, the contribution to GDP equal to 4.23%. We have some reason for this condition, one of the reason is the fluctuations of commodity prices especially for mineral and coal. However, the contribution in 2016 is lower than 2011, the development of mining industries becomes more evenly distributed, because the spread of mining industries have captured until Papua Province, Central Sulawesi Province, Bangka Belitung Province, West Nusa Tenggara Province, and East Kalimantan Province [11].

According to report from Price Water House Coopers Indonesia, the mining sector contributes a higher proportion of Indonesian exports, particularly as mining products are generally priced in US dollars, however, the contribution of the sector to Indonesian exports has also fallen off in the last few years. The implementation of the ban on exports of unprocessed (or not-sufficiently processed) minerals in January 2014 and the introduction of a significant (and progressively increasing) export duty on mineral concentrates, have resulted in an ongoing decline in mineral production over recent years. The mining industry’s contribution to total Indonesian export revenues during 2014-2016 was however consistent at 13% (down from 17% in 2013). The Government, however, hopes that the total contribution of the mineral sector will increase once mineral processing and refining facilities are in place, generating higher value products and when the relaxation of the export ban on low-grade nickel ores and washed bauxite takes effect in 2017.
Based on Figure 1, the results of income multipliers show the value of mining sector is 0.7062; this value indicates that every increase of one billion rupiah output was generated from this sector, then the total income of the community will increase by 706 million rupiah. Next, the multiplier value of manufacturing industry sector is 0.5018; this value indicates that every increase of one billion rupiah output was generated from this sector, then the total income of the community will increase by 501 million rupiah. This finding suggests that it is possible that the high income multipliers generated from the mining sector come from the contribution of priority economic sectors. Where the priority economic sector are expected to create employment opportunities and increase revenues in the sector that this sector can be the foundation of an economy [1].

From Figure 2, the results of output multipliers show the value of mining sector is 1.2426; this value indicates that every increase of one billion rupiah output was generated from this sector, then the total output of this sector will increase by 1242 million rupiah. Next, the multiplier value of manufacturing sector...
industry sector is 1.7722; this value indicates that every increase of one billion rupiah output was generated from this sector, then the total output of this sector will increase by 1772 million rupiah. This findings cannot be separated by the role of labor, because it’s become one of the importance production factor that it represents all of the people that are available to transform into goods or services. If the government wants to achieve this sector growth, the government should provide well educated and well trained labor to ensure that they can produce goods and services with a highly efficient and qualified.

From income and output multiplier, we found that the multiplier value of mining sector can be classified with high category. However, this sector have effect, its come from in site or out site, such as degradation of water and air quality, flora and fauna habitats, erosion and sedimentation, potential of social impact, and others. One of important things is the environmental aspects include post mining land use, abandoned mining sites community development, and illegal mining. Government should have make many community development programs. The benefit of the program are it can be the solutions to alleviate poverty and it will be a key factor to make this industry more sustainable.

In line with above statement that our main economic objectives remain unchanged: to promote growth and enhance people’s welfare supported by sustainable growth, resilient economic sector, inclusive economic development, and macroeconomic and financial stability. The Government remains committed to continuing structural reforms and accelerating infrastructure development to achieve these objectives. However, both domestic and international challenges still persist, which results adjustments on national development goals to be more realistic. In addition, the Government also put forward efforts to promote social welfare for low-level income society through jobs creation and social protection improvement.

On the other hand, we have the guidance for energy sector development. It came from The government’s RPJMN for 2015–2019 reaffirms Indonesia’s commitments to reducing its greenhouse gas emissions and strengthening its national energy security. The RPJMN states the government’s primary energy-related priorities as (i) strengthening the availability of primary energy through oil production, supported by gas and coal production; (ii) increasing the domestic use of primary energy resources; and (iii) achieving a 96.6% electrification ratio. The RPJMN also establishes goals for biodiesel and bioethanol, and specifies that renewable energy should reach 10%–15% of the energy mix. Specifically, 7.5 GW of renewable energy generation should be added (geothermal, hydropower, and micro hydro), and initial trials of nuclear and marine-based energy should be implemented [5].

4. Conclusion
According to the analysis and findings, this study found that (1) Indonesian mining sectors ranked 6th with contribute amount of 6.81% on national total output; (2) Based on total gross value added, this sector contribute amount of 12.13% or ranked 4th; (3) The value from income multiplier is 0.7062 and the value from output multiplier is 1.2426.

The suggestion that can be given, (1) the Indonesian government should find the other alternative economic sector besides the mining sector and they must concern to develop this sector; (2) the Government of Indonesia can increase the export targets where not in the form of raw material but in the form of goods or services, because it can increase the value added and Indonesian economy generally; and (3) Government must be push the mining industries to make more community development program because this program could be one of the solutions to alleviate poverty. Currently it is regarded as being closely related to the environmental issue, and it constitutes a key factor in a successful sustainable mining development. It must be a special attention, since iron, steel, cement, ceramic, glass, and textile industries are all heavy energy consumers with potential for substantial improvements in energy utilization. Collectively, the industrial sector accounts for almost half of all energy consumption in Indonesia, but consumes energy inefficiently when compared with international benchmarks. Conversion efficiency at the power plant level has remained almost constant for 20 years.
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