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# The Effect of Mining Sector Determinants on Economic Growth

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**Abstract**: This study aims to examine the relationship between import and export of mining sector determinants represented by the non-metallic, metallic, energy mineral, fertilizer and jewelry sun-sectors towards Malaysia's Gross Domestic Product (GDP). Data from the year 2001 to 2015 were analyzed. An econometric model was developed using Ordinary Least Square (OLS) and Unit Root Test was performed. Result of the study reveals that there is a significant relationship between fertilizer import, jewelry import, energy mineral export and non-metallic export determinants towards GDP in Malaysia.

**Keywords**: Energy Mineral, Export, Fertilizer, GDP, Import, Jewellery, Mining sector, Mining determinants, Metallic, Non-metallic

## 1 Introduction

In the late 1980s, Malaysia's Mining Industry had fallen since the collapse of the tin market. The mining sector was neglected and over shadowed by the increase of palm oil industry and property development in economy. According to Department of Statistics Malaysia (DOSM) [1], the mining sector is one of the important sectors that contributes about 9.6% to our Gross Domestic Product (GDP) for the first quater in 2015. Figure 1 shows the yearly GDP for mining sector from the year 2001 until 2015.

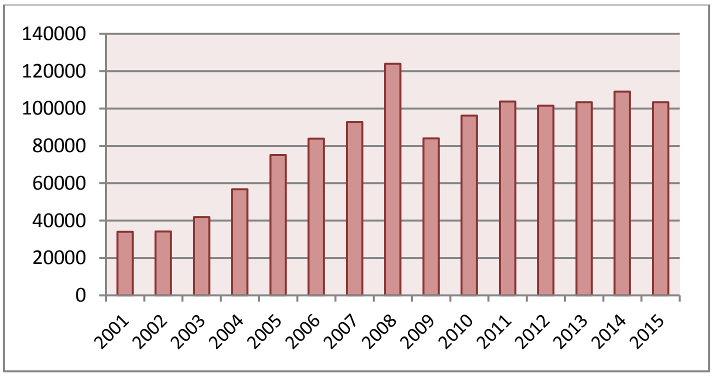


Figure 1: GDP of Mining Sector from year 2001 until 2015

There are about 98 iron ore mines, 15 gold mines, 14 tin mines and 7 coal mines operating in the country. Malaysia is endowed with over 33 different mineral types, comprising metallic, non-metallic and energy minerals, worth billion of dollars in economic potential. The metallic mineral sub-sector produces minerals such as tin, gold, bauxite, iron-ore, ilmenite and other associated minerals. While the non-metallic or also known as industrial mineral sub-sector comprises of limestone, clays, kaolin, silica, sand and gravel, and mica. The energy sub-sector produces mineral fuels such as coal, natural gas and crude petroleum. Processed mineral products produce cement, nitrogen fertilizer minerals (ammonia and urea), refined petroleum products, crude steel, titanium dioxide pigment and refined tin.

Mining product demands have increased all over the world causing the import and export of mining product to increase drastically. The mining subsector GDP is different for both import and export. Figures 2 and 3 exhibit the gross domestic product of import and export for mining industry respectively.

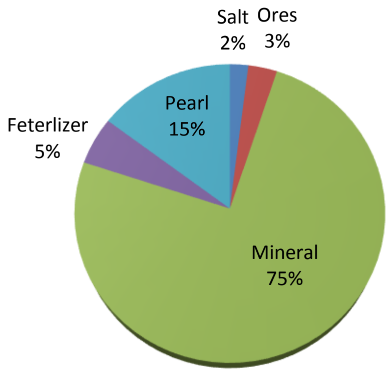


Figure 2: The GDP of Import Sub-sector for Mining Industry

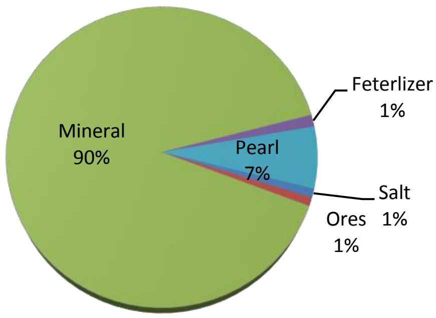


Figure 3: The GDP of Export Sub-sector for Mining Industry

Based on Figure 2, it clearly shows that the highest percentage recorded for GDP of import sub-sector for mining industry is Mineral sector (75%) followed by Pearl sector (15%) and the lowest percentage of import was from Salt sector (2%). Meanwhile, referring to Figure 3, the highest GDP of export sub-sector for mining industry was Mineral sector (90%) and the smallest was shared by three sub-sectors (Fertilizer, Salt, Ores) which contributed about 1% to the GDP of export sub-sector for mining industry. The core sector that drives the growth in an economy is mining sector which not only contributes to GDP of one’s country but also acts as a catalyst for the growth of other core industries like power, steel and ceement [2]. For example, Kakko [3] explained that the mining industry has been one of the few investment making sectors in Finland.

Nowadays, Malaysia is focusing on large-scale mining which includes gold, iron ore and copper. In 2012, the production of iron ore topped other major minerals valued at RM2.02 billion followed by gold (RM700.8 million), coal (RM442.2 million) and tin (RM234.5 million) [4]. Therefore, the aim of this paper is to analyze the determinants of the mining sector to the growth and development of Malaysia economy within the year 2001 and 2015 using simple linear regression for the promotion of exportation.

## 2 Methodology

### *A Source of Data*

In this study, the secondary data was used. This study focuses on the effect of mining sector determinants of economic growth. In this study, the data used were obtained from Malaysia External Trade Statistics (METS Online) [5] for sub-sector data of mining industry. Data of GDP (quarter) are extracted from the Monthly Statistical Bulletins (MSB) [6].

### *B Description of Data*

Table 1 below displays the summary of variables used for this study. There are 10 independent variables involved namely SI, OI, MI, FI, PI, SE, OE, ME, FE and PE to estimate the GDP.

Table 1: Summary of Variable

| Label | Type | Description | Unit |
|---|---|---|---|
| GDP | Dependent Variable | GDP per capita is often used as average income, population size of a country wealth, especially when making comparisons with other countries | RM (Millions) |
| SI | Independent Variable | Non-metallic sub-sector that covers item code HS25 (salt, sulphur, earth and stone, plastering materials, lime and cement) specifically for the import. | RM (Millions) |
| OI | Independent Variable | Metallic sub-sector that covers item code HS26 (ores, slag and ash) specifically for the import. | RM (Millions) |
| MI | Independent Variable | Energy mineral sub-sector that covers item code HS27 (mineral fuel, mineral oils and product of their distillation, bituminous substances) specifically for the import. | RM (Millions) |
| FI | Independent Variable | The sub-sector that cover code HS31 which is the fertilizer specifically for the import. | RM (Millions) |
| PI | Independent Variable | Jewelry sub-sector that covers code HS71 (pearls, stones, metal clad with precious metal and articles, jewelry and coins) specifically for the import. | RM (Millions) |
| SE | Independent Variable | Non-metallic sub-sector that covers item code HS25 (salt, sulphur, earth and stone, plastering materials, lime and cement) specifically for the export. | RM (Millions) |
| OE | Independent Variable | Metallic sub-sector that covers item code HS26 (ores, slag and ash) specifically for the export. | RM (Millions) |
| ME | Independent Variable | Energy mineral sub-sector that covers item code HS27 (mineral fuel, mineral oils and product of their distillation, bituminous substances) specifically for the export. | RM (Millions) |
| FE | Independent Variable | The sub-sector that cover code HS31 which is the fertilizer specifically for the export. | RM (Millions) |
| PE | Independent Variable | Jewelry sub-sector that covers code HS71 (pearls, stones, metal clad with precious metal and articles, jewelry and coins) specifically for the export | RM (Millions) |

### *C Statistical Analysis*

#### i. Descriptive Analysis

In this study, the descriptive analysis is performed to analyse the mean, minimum and maximum, and the standard deviation for the variable. The unit root and stationarity test is performed to see the stationarity such as Augmented Dickey-Fuller (ADF) [7,8]. The Ordinary Least Square (OLS) econometric statistical technique is also applied in this study. Several statistical analyses are used in this study such as F-test (goodness of the model), Durbin-Watson test (checking for serial correlation) and Variance inflation factors (VIF) (checking for multicollinearity).

#### ii. Model Specification

The econometric model of the study is specified as below;

$$GDP = \beta_0 + \beta_1 SI_t + \beta_2 OI_t + \beta_3 MI_t + \beta_4 FI_t + \beta_5 PI_t + \beta_6 SE_t + \beta_7 OE_t + \beta_8 ME_t + \beta_9 FE_t + \beta_{10} PE_t + \beta_{11} GDP_{t-1} \quad (1$$

where :
$GDP_t$ = Gross Domestic Product for Mining and Quarrying Sector
$SI_t$ = Import Non-Metallic Mineral (RM million)
$OI_t$ = Import Metallic Mineral (RM million)
$MI_t$ = Import Energy Mineral (RM million)
$FI_t$ = Import Fertiliser (RM million)
$PI_t$ = Import Jewelries (RM million)
$SE_t$ = Export Non-Metallic Mineral (RM million)
$OE_t$ = Export Metallic Mineral (RM million)
$ME_t$ = Export Energy Mineral (RM million)
$FE_t$ = Export Fertiliser (RM million)
$PE_t$ = Export Jewelries (RM million)
$GDP_{t-1}$ = Lag 1 of Gross Domestic Product for Mining and Quarrying Sector
$\beta_0, \beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7, \beta_8, \beta_9, \beta_{10}, \beta_{11}$ = Constants

The econometric model is used to see the effect of mining and quarrying sector on economic growth. The model suggests that the increase in the mining and quarrying subsectors such as import of non-metallic minerals, metallic minerals, energy minerals, fertilizer, jewelers and export of non-metallic minerals, metallic minerals, energy minerals, fertilizer, and jewelers will cause the increase in gross domestic product of mining and quarrying sector. The increase of imports and exports in mining and quarrying sector will positively affect the gross domestic product based on economics prediction in Malaysia economy. However, the parameters estimated in the equation are $\beta_0, \beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7, \beta_8, \beta_9, \beta_{10}$ and $\beta_{11} > 0$.

## 3 Results and Discussion

### *A Descriptive Analysis*

The summary statistics for variables under study is tabulated in Table 3. All the values presented in Table 2 are measured in RM (millions). From the table presented, the minimum, maximum and mean values for GDP are RM7,218 million, RM36,101 million and RM 20,732.38 million respectively. For overall, the most contributed sub-sector towards the GDP is Mineral sub-sector which has the highest value for minimum, maximum and mean value of about RM6,479.03, RM46,277.5 and RM23,811.03 respectively.

Table 2 : Descriptive Statistics of Import and Export on Mining and Quarrying Subsector

| Statistic | Minimum | Maximum | Mean | Std. Dev |
|---|---|---|---|---|
| GDP | 7218 | 36101 | 20732.38 | 7222.131 |
| SI | 159.853 | 598.714 | 347.741 | 138.487 |
| OI | 86.047 | 1452.426 | 545.579 | 348 |
| MI | 3135.299 | 30322.54 | 13216.83 | 8059.612 |
| FI | 177.807 | 2390.693 | 911.45 | 478.749 |
| PI | 757.578 | 5649.495 | 2602.807 | 1274.002 |
| SE | 64.943 | 486.274 | 253.857 | 117.885 |
| OE | 8.727 | 1941.753 | 239.511 | 381.563 |
| ME | 6479.03 | 46277.5 | 23811.03 | 11224.45 |
| FE | 83.324 | 687.998 | 335.858 | 146.388 |
| PE | 497.439 | 2943.429 | 1756.301 | 717.094 |

### *B Comparing Mean*

Based on Figure 4, we can see the mean import for mining and quarrying subsectors. We are interested to determine the mean import in different subsectors which are non-metallic minerals, metallic minerals, energy minerals, fertilizer and jewelleries. The pie chart shows the highest mean is 13216.83 for energy minerals and the lowest mean is 347.741 for non-metallic minerals.

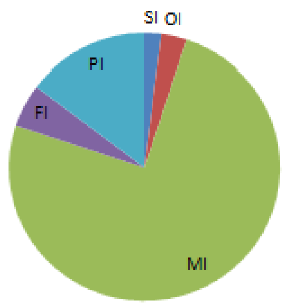


Figure 4 : Mean For Import Subsector of Mining and Quarrying

Based on Figure 5, we can see the mean export for mining and quarrying subsectors. We are interested to determine the mean import in different subsectors which are non-metallic minerals, metallic minerals, energy minerals, fertilizer and jewelries. The pie chart shows the highest mean is 23811.03 for energy minerals and the lowest mean is 239.511 for metallic minerals.

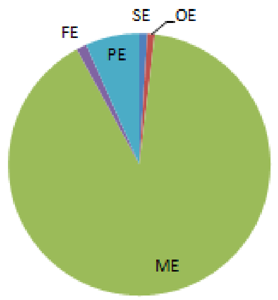


Figure 5: Mean For Export Subsector of Mining and Quarrying

## *C Econometric Model*

### i. Model 1

The econometric model is regressed as follow :

$$\hat{G}DP = 3510.601 - 6.413SI_t - 0.845OI_t - 0.225MI_t + 3.441FI_t - 1.678PI_t + 5.79SE_t + 1.988OE_t + 0.533ME_t + 1.336FE_t + 0.737PE_t \quad (1)$$

Table 3 : OLS Result For First Model

| Dependent Variable : GDP | | | | |
|---|---|---|---|---|
| Method : Least Square | | | | |
| Sample : 2001 - 2015 | | | | |
| Include observation : 59 | | | | |
| Variable | Coefficient | Std. Error | t-Statistics | Prob. |
| Intercept | 3510.601 | 1210.007 | 2.901 | **0.006** |
| SI | -6.413 | 8.170 | -0.785 | 0.436 |
| OI | -0.845 | 2.115 | -0.399 | 0.691 |
| MI | -0.225 | 0.168 | -1.338 | 0.187 |
| FI | 3.441 | 1.426 | 2.413 | **0.020** |
| PI | -1.677 | 0.704 | -2.384 | **0.021** |
| SE | 5.790 | 5.557 | 1.042 | 0.303 |
| OE | 1.988 | 1.538 | 1.292 | 0.203 |
| ME | 0.533 | 0.124 | 4.313 | **< 0.0001** |
| FE | 1.336 | 4.112 | 0.325 | 0.747 |
| PE | 0.737 | 1.243 | 0.593 | 0.556 |
| $GDP_{t-1}$ | 0.378 | 0.109 | 3.464 | **0.001** |
| $R^2$ | 0.941 | Mean Dependent var | | 20927.102 |
| Adj $R^2$ | 0.928 | S.D Dependent var | | 7123.506 |
| Sum Square Resid | 172464369.119 | F-statistic | | 68.643 |
| DW | 1.429 | Prob(F-statistic) | | **< 0.0001** |

The estimated model shows that the econometric model was fitted to estimate the GDP. Fertilizer import, jewelleries import, energy minerals import and gross domestic product at lag 1 were significant in determining the GDP of mining and quarrying sector. The backward model selection was implemented to obtain the best fitted model.

### ii. Model 2

$$\hat{G}DP = 3025.299 + 2.211FI_t - 1.8766PI_t + 10.009SE_t + 0.369ME_t + 0.452GDP_{t-1} \quad (2)$$

Table 4 : OLS Result For Best Fit Model

| Dependent Variable : GDP | | | | |
|---|---|---|---|---|
| Method : Least Square | | | | |
| Sample : 2001 - 2015 | | | | |
| Include observation : 59 | | | | |
| Variable | Coefficient | Std. Error | t-Statistics | Prob. |
| Intercept | 3025.299 | 778.427 | 3.886 | 0.000 |
| FI | 2.211 | 1.042 | 2.121 | 0.039 |
| PI | -1.877 | 0.490 | -3.826 | 0.000 |
| SE | 10.009 | 3.801 | 2.633 | 0.011 |
| ME | 0.370 | 0.060 | 6.169 | < 0.0001 |
| $GDP_{t-1}$ | 0.452 | 0.087 | 5.189 | < 0.0001 |
| $R^2$ | 0.936 | Mean Dependent var | | 20927.102 |
| Adj $R^2$ | 0.930 | S.D Dependent var | | 7123.506 |
| Sum Square Resid | 187700455.447 | F-statistic | | 155.610 |
| DW | 1.255 | Prob(F-statistic) | | **< 0.0001** |

Comparing Model 1 and 2, Model 2 is better to determine the economic growth. Based on the coefficient for FI, it can be said that import of 1 unit of the fertilizer will increase the GDP by RM2,211,000 while increasing 1 unit of PI will reduce the GDP by RM1,877,000. The increasing of 1 unit of SE will increase the GDP by RM10,009,000. Energy minerals export will increase the GDP by RM370,000 when 1 unit of ME is increased. Lastly, Gross Domestic Product with lag 1 will increase the GDP by RM452,000 for every 1 year increase. Nevertheless, The econometric model fitted has the positive serial correlation since the Durbin-Watson value was 1.255. According to Jamil and Alias [9], the DW value of less than 2 will have positive serial correlation. In these cases, the multicollinearity does not exist since the VIF values is less than 10 [9]. The result shows that the DW value increases with the first differencing order which means that the GDP is not stationary for this fitted model. The ACF and PACF plot can be seen in Figure 6 and Figure 7.

### *D Stationarity of GDP*

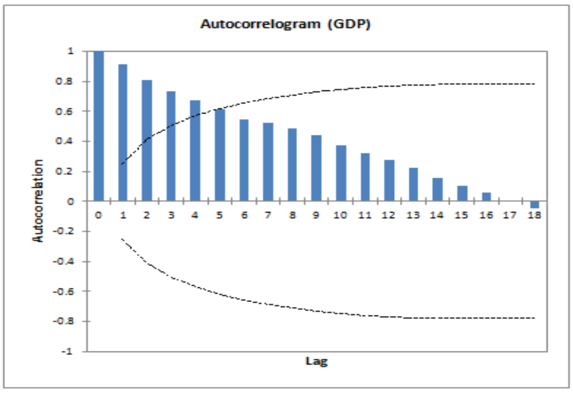


Figure 6 : ACF (GDP)

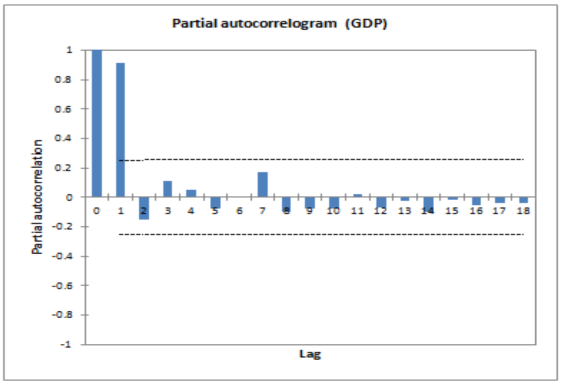


Figure 7 : PACF (GDP)

Figure 6 and Figure 7 display the ACF and PACF plot of original series of GDP. Based on Figures 6 and 7, the GDP is not in stationary. The stationarity can be transformed into stationary by differencing the original data series.

### *E Unit Root and Stationarity Test*

### i. Without Differencing

Table 5 : ADF, PP and KPSS Without Differencing

| Variables | ADF | | PP | | KPSS | |
|---|---|---|---|---|---|---|
| | With Trend | Without Trend | With Trend | Without Trend | With Trend | Without Trend |
| GDP | 0.456 | 0.405 | 0.431 | 0.429 | < 0.0001 | < 0.0001 |
| SI | 0.001 | 0.664 | 0.002 | 0.849 | < 0.0001 | < 0.0001 |
| OI | < 0.0001 | 0.223 | < 0.0001 | 0.504 | < 0.0001 | < 0.0001 |
| MI | 0.238 | 0.645 | 0.205 | 0.679 | < 0.0001 | < 0.0001 |
| FI | 0.027 | 0.060 | 0.044 | 0.119 | 0.000 | 0.000 |
| PI | 0.000 | 0.463 | 0.001 | 0.693 | < 0.0001 | < 0.0001 |
| SE | 0.824 | 0.456 | 0.914 | 0.520 | 0.001 | 0.001 |
| OE | 1.000 | 1.000 | 1.000 | 1.000 | 0.000 | 0.000 |
| ME | 0.183 | 0.633 | 0.122 | 0.655 | < 0.0001 | < 0.0001 |
| FE | 0.005 | 0.161 | 0.006 | 0.298 | < 0.0001 | < 0.0001 |
| PE | 0.020 | 0.480 | 0.020 | 0.652 | < 0.0001 | < 0.0001 |

Table 6 : ADF, PP and KPSS With Differencing

| Variables | ADF | | PP | | KPSS | |
|---|---|---|---|---|---|---|
| | With Trend | Without Trend | With Trend | Without Trend | With Trend | Without Trend |
| GDP_1 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | 0.616 | 0.616 |
| SI_1 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | 0.807 | 0.807 |
| OI_1 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | 0.899 | 0.899 |
| MI_1 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | 0.843 | 0.843 |
| FI_1 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | 0.612 | 0.612 |
| PI_1 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | 0.872 | 0.872 |
| SE_1 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | 0.177 | 0.177 |
| OE_1 | 0.006 | 0.018 | 0.004 | 0.017 | 0.010 | 0.010 |
| ME_1 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | 0.914 | 0.914 |
| FE_1 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | 0.933 | 0.933 |
| PE_1 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | 0.746 | 0.746 |

Table 5 gives the Augmented Dickey-Fuller (ADF), Philips-Perrons (PP) and Kwiatkowski-Philips-Schmidt-shin (KPSS) test results. The ADF, PP and KPS were performed to further confirm on the stationarity of the variable. The result shows the p-values for every variable when testing for the unit root test with and without trend. The non-stationary series can be transformed using differencing technique to make the series become stationary [9].

Table 6 shows that all series were stationary after performing order 1 of differencing to the series. The unit root test above was conducted with and without trend. Since the series was stationary, it will prevent spurious regression to occur.

## 4. Conclusion

The study focused on mining and quarrying sector contribution to the economic growth and development of the country; by promoting the significant mining and quarrying sector determinants which are import and export of non-metallic minerals, metallic minerals, energy minerals, fertilizer and jewelleries. The findings of this research highlighted the importance of mining and quarrying sector determinants and discovered that import of fertilizer and export of non-metallic minerals need to be promoted to enhance further economic growth, since they have a positive significant effect on the economic growth. However, the effect of energy minerals export as determinant of mining and quarrying sector showed that it is yet to improve economic growth of the country. The mining and quarrying sector should be continued to satisfy demands from nations such as China and India.

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