Construction and Mining Including Quarrying Sector of Malaysia: A Comparative and Causality Analysis between 2001 -2010

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Abstract
Mining including quarrying and construction sectors are the two major sectors of industrialized and developed countries. Many other major productive sectors of economy rely on the activities and output of these sectors. The purpose of this study is to examine the causal relationship between these two fundamental sectors of Malaysian economy. The Granger causality model is used to investigate the link and direction of link between construction and mining and quarrying sector of Malaysia. The results of the study are informative and useful for ministries of sectors, policy makers and interested parties of the sector.

Keywords: construction; mining and quarrying; time series; granger causality; GDP.

INTRODUCTION
Malaysia has long been recognized as one of the world’s leading tin producers and an important producer of other non-energy materials including bauxite, coal, copper, iron gold. The Mining and Quarrying sector plays a significant role in socio-economic development of a country, since other sectors of economy depend on it. However, mining contribution to the economy has declined. From 2001 to 2010, as a percentage of gross domestic product (GDP) contribution mining and quarrying output declined from 10.3% to 7.0%; while the proportion of employed labor force increased from 0.3 percent to 0.5% in the same period. The contribution to GDP during 2008, 2009 and 2010 gradually decreased to 7.9%, 7.5% and 7% respectively. The labor employment contribution in the same period remained constant at 0.5% of the entire labor force of Malaysia. A study was conducted under the title “Malaysia’s Mineral Resources” concluded that there are bulk quantities of mineral resources available in Malaysia (Pei, 2000). The Mining industry is mainly focused on limestone and granite quarries (Wan, 2007). Malaysia has abundant reserve of limestone and granite, which is widely used as raw material and is an important factor in the production of various construction and building materials like cement, plastic, paper, paint rubber and glass.

The construction sector is also an important part of an economy and plays a very strong and effective role in the socio-economic development of society. It is also closely associated with other sectors of economy. The contribution of the construction sector to GDP of Malaysia during 2008, 2009 and 2010 was 3.0%, 3.2% and 3.1% respectively. The proportion of employed labor force in construction sector remained constant at 9% during 2008, 2009 and 2010 (Time series production of selected products 1963-2010, 2010).

The two sectors mining including quarrying and construction have an important effect on socio-economy, environment and manpower in the country and make significant contribution to GDP, earn foreign exchange and bring foreign investment in the country. The purpose of this study is to examine the direction of causality link between mining and
quarrying sector and the construction sector of Malaysia and compare the contribution of these two sectors in aggregate economy during the last decade from 2001 to 2010.

LITERATURE REVIEW

Overview of Mining Including Quarrying and Construction Sector of Malaysia

Both mining including quarrying and construction sector play a pivotal role in the development of any nation. They are the backbone of any economy and guarantee the continued prosperity of both developing and developed nations, because of their strong backward and forward linkage with other sectors of the economy. Mining and quarrying activities are closely associated with construction building materials, infrastructure projects and the manufacturing sector. Most popular products of quarry are used in construction sector without any manufacturing process e.g.-as stone ballast in road and railway tracks and as quartz sands in high quality material industrial production such as glass. It is also used in concrete work. In concrete product approximately 80% is aggregate similarly asphalt is made of 95 % aggregate (Ginevra Balletto & Furcas, 2011). The mining and quarrying sector’s continuous supply of raw material to other sectors of economy specially manufacturing and construction, is the assurance for the socio-economic development of country (Wan, 2007)

The construction sector is currently the third largest sector of Malaysian economy. Over the last twenty years the construction sector has been consistently contributing approximately 3 to 5 % of GDP and provides employment to more than one million people who represent 8-9% of total work force of Malaysia ("Time series production of selected products 1963-2010," 2010). It supports approximately 140 other industries of Malaysian economy including mining and quarrying. This study is focused on the relationship between construction and mining and quarrying sector of Malaysia and their role in aggregate economy.

Analysis of Popular Past Studies on Causality Links among Sectors of Economy

A wide range of literature is available on causality between construction and various sectors of economy. A number of published studies have shown the strong link between construction and economic growth.

A study was conducted in Singapore to examine the role of construction sector in Singapore’s economy during 1960-1986. The study concluded that the construction industry played a significant role in economic development of Singapore (Ofori, 1988). Another study conducted by (Tse & Ganesan, 1997) on Hong Kong construction sector activities and economic growth and resolved that growth in GDP pushed construction activities. Inverted U shape Bon’s curve used by (Ruddock & Lopes, 2006) to analyzed the effect of construction on economic growth in developing, newly industrialized and developed economies. Result shows that the construction sector plays a powerful role in the development of a country. Another popular study regarding construction demand stated that demand for construction work is at peak in the early stage of economic development and decreases after attaining a high level of economic development stage (Wells, 1986). Granger causality approach used by Green to examine the linkage and impact of residential against nonresidential construction investment on GDP and established that residential construction investment was Granger caused GDP, while nonresidential did not cause to GDP during the study period (Green, 1997). A study was conducted in Pakistan to examine causality link between construction sector and economic growth. The study used annual time series data of construction output and GDP from 1950-2005. The outcome of the study is unidirectional relationship between construction sector and economic growth of Pakistan. Construction activities and economic growth of Pakistan. Construction activities are Granger caused GDP (Khan, 2008). Another study conducted in Malaysia on construction sector and economic growth of Malaysia, using quarterly time series data (2000-2010) established that there is bidirectional relationship between economic growth and construction sector of Malaysia (Khan, Noor Amila Bt Wan Abdullah Zawawi, & Khamidi, 2012).

Unfortunately there is hardly any literature available that discusses the relationship and linkage between the two important sectors construction and mining including quarrying of the economy. The objective of this paper is to conduct empirical analysis over causality link and direction of relationship between the two fundamental sectors of Malaysian economy construction and mining and quarrying.

RESEARCH HYPOTHESIS

In the light of the objective of the study following hypothesis are set for Granger causality analysis:

Hypothesis-1
Null hypothesis: H0: Construction sector does not affect the mining and quarrying sector.
Alternate hypothesis: H1: Construction sector affects the mining and quarrying sector.

Hypothesis-2
Null hypothesis: H0: Mining and quarrying sector does not affect the construction sector
Alternate hypothesis: H1: Mining and quarrying sector affects the construction sector.

Research Methodology
A descriptive statistics analysis is used to find out the basic properties of the data for comparing the two sectors construction and mining and quarrying. This analysis is also used to measure correlation between the sectors. Inferential statistics analysis is used to examine the causality link between the concerned sectors. For this purpose Granger causality model is used in the study.

DATA AND SAMPLE SIZE

The secondary quarterly time series data from first quarter 2001 to fourth quarter 2010 is used to conduct this study. The data was obtained from Statistics Department Government of Malaysia, in money value terms i.e. Ringgit Malaysia. The two variables, data series construction output and mining and quarrying output are used in natural logarithmic form to maintain the uniformity in the data and to measure the long run elasticity of the two series i.e. LCON and LMQG.

Granger Causality Model and Application

The Granger causality equations are used to test the above hypothesis in order to know the causality link and the direction between construction and mining and quarrying sectors, with an assumption that future value cannot forecast present and past value. Following model equations are suggested for causality test:

\[ \text{LCON}_t = \beta_0 + \sum_{i=1}^{k} \beta_i \text{LCON}_{t-i} + \sum_{i=1}^{r} \alpha_i \text{LMQG}_{t-i} + \mu_t \]  
(1)

\[ \text{LMQG}_t = \beta_0 + \sum_{i=1}^{k} \beta_i \text{LMQG}_{t-i} + \sum_{i=1}^{r} \alpha_i \text{LCON}_{t-i} + \mu_t \]  
(2)

Causality between the sectors can be identified by estimating the above two equations 1 and 2 through testing the null hypothesis \( H_0 : \sum_{i=1}^{k} \beta_i = 0 \) against the alternate hypothesis \( H_1 : \sum_{i=1}^{k} \beta_i \neq 0 \). If \( C_1 \) is statistically significant for equation 1 but not significant for equation 2, then there is unidirectional relationship. This means the construction sector affects the mining and quarrying and mining quarrying does not affect the construction. The reverse causation exists when \( C_1 \) is significant for equation 2 but insignificant for equation 1. That indicates the direction of causality is moving towards construction sector from mining and quarrying. The bidirectional causality exists when \( C_1 \) is statistically significant for both Equations 1 and Equation 2, indicating that causality runs both ways, from construction to mining sector and mining quarrying to construction sector. \( \beta_2 \) is uncorrelated and white noise error term in the model equations.

F- Statistics used to test the possibilities of existence of various forms of causality as mentioned above. If estimated F value exceeds the critical value of F at either 1%, 5% or 10% levels of significance, it rejects the null hypothesis of no causality or lack of causality (Granger & Newbold, 1974).

STATIONARY SERIES PROBLEM

Granger causality model depends on time series variables and mostly time series variables have stationarity and unit root problem that produce unreliable results and form spurious regression due to inefficient regression coefficient. Therefore unit root test is a necessary condition for Granger causality analysis. The test examines whether the concerned variable series are stationary or non-stationary. Non-stationary means series has unit root problems and it can become stationary by taking log of series or difference of series like first order difference or second order difference (Dickey & Fuller, 1979). There are several tests available to examine stationarity problem in the series. Augmented Dickey Fuller (ADF) and Phillip Peron (PP) tests are more popular in this regard. These tests not only identified the unit root problem but also gave information about the required degree of difference for stationarity in the series. The order of difference for converting non-stationary series to stationary will decide the order of integration. If the series differed “n” times to become stationary, it is known as integrated order I(n), and the variables are considered co-integrating variables by which co-integrating equation can be developed. The co-integrating equation can be used to deduce long run equilibrium relationships between the variables. ADF test is conducted on the basis of Equation 3 and Equation 4 given below. Equation 3 is used to examine stationarity in construction output series while Equation 4 is used to test stationarity in mining and quarrying output series.

\[ \Delta \text{LCON}_t = \alpha_0 + a_1 T + a_2 \text{LCON}_{t-1} + \sum_{i=1}^{k} \alpha_i \Delta \text{LCON}_{t-i} + \mu_t \]  
(3)

\[ \Delta \text{LMQG}_t = b_0 + b_1 T + b_2 \text{LMQG}_{t-1} + \sum_{i=1}^{k} \beta_i \Delta \text{LCON}_{t-i} + \mu_t \]  
(4)

In above equations \( a_0 \) and \( b_0 \) are drift terms and \( T \) is trend in both data series. Stationarity in construction series is tested with null hypothesis \( H_0 : a_2 = 0 \) against the alternate hypothesis \( H_1 : a_2 \neq 0 \). Similarly stationarity in mining and quarrying series is tested with null hypothesis \( H_0 : b_2 = 0 \) against the alternate hypothesis \( H_1 : b_2 \neq 0 \). Acceptance of null hypothesis means series has unit root problem. “n” represents to lag order to white noise error term and \( \mu_t \) is an error term (Dickey & Fuller, 1979).

DISCUSSION ANALYSIS AND RESULTS

Summary of Descriptive Statistical Analysis

Summary of descriptive statistical analysis of two important sectors of Malaysian economy, construction and mining and quarrying for the study period 2000-2010 is presented in Table 1, Table 2 and Table 3 below. The basic properties of the data series are shown in Table 1. The mining and
quarrying sector average quarterly output was 2.5 times greater than construction sector during study period. The mean value output for construction sector was RM 3871 million with standard deviation RM 357 million, while mining and quarrying sector mean output was RM 10162 million with standard deviation of RM 579 million. The smaller value of standard deviation of construction data series as compared to mining and quarrying series shows that the construction sector was more stable than mining and quarrying sector during 2001-2010. The construction sector data series is positively skewed with one peak, while the mining and quarrying sector data series is skewed slightly negatively. The construction sector output value fluctuated between RM 3324 and RM 4814 million during the study period. The minimum and the maximum value of mining and quarrying sector output were RM 8932 and RM 11302 million respectively in the same period of time.

Table 1 Properties Of Data Series

<table>
<thead>
<tr>
<th>Description</th>
<th>Construction</th>
<th>Mining and quarrying</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>3871.15</td>
<td>10161.60</td>
</tr>
<tr>
<td>Median</td>
<td>3786.50</td>
<td>10176.50</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>356.96</td>
<td>578.87</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>3.86</td>
<td>2.44</td>
</tr>
<tr>
<td>Skewness</td>
<td>1.13</td>
<td>-0.19</td>
</tr>
<tr>
<td>Minimum</td>
<td>3324</td>
<td>8932</td>
</tr>
<tr>
<td>Maximum</td>
<td>4814</td>
<td>11302</td>
</tr>
<tr>
<td>Count</td>
<td>44</td>
<td>44</td>
</tr>
</tbody>
</table>

Data source: Department of Statistics Government of Malaysia

Output Comparison

Output trend of construction and mining and quarrying sector is shown in Figure 1. Mining and quarrying sector has a positive trend from 2001 to 2004, during this period output increased from RM 9000 million to RM 11000 million; then has stability during 2005 to 2007 and from 2007 to 2010 there was a continuous decreasing trend in output. While construction sector has stability in output level from 2001 to 2007 and thereafter has positive trend in it. At 2001, output was RM 3324 million and in 2010 reached to RM 4814 million. The average output of mining and quarrying is 2.5 times higher than the construction sector i.e. RM 10162 million and RM 3871 million respectively as shown in Table 1.

Contribution to GDP

Figure 2 depicts the contribution of the construction and mining and quarrying sectors to GDP of Malaysia. The contribution of Mining and quarrying sector has throughout negative trend during the study period. In 2001 Mining and quarrying contribution was 11% and in 2010, it was around 7% of GDP. The average contribution of this sector was 9% during 2001-2010. The contribution of the construction sector was decreasing during 2001 to 2007. However the declining rate was too slow. From 2007 to 2010 construction sector gradually increased its contribution to GDP. The average contribution of the construction sector was 3.45 % of GDP with the approximate fluctuation of 1.5%. It is 2.6 times smaller than mining and quarrying, contribution to GDP, as shown in Table 2.

Table 2 Contributions To Gdp

<table>
<thead>
<tr>
<th>Sectors</th>
<th>Mean</th>
<th>variance</th>
<th>Min. value</th>
<th>Max. value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>3.45</td>
<td>0.15</td>
<td>2.87</td>
<td>4.18</td>
</tr>
<tr>
<td>Mining &amp; Quarring</td>
<td>9.00</td>
<td>1.54</td>
<td>6.72</td>
<td>10.97</td>
</tr>
</tbody>
</table>

Data source: Department of Statistics Government of Malaysia

GROWTH COMPARISON

Growth comparison value between construction and mining and quarrying sector are available in Table 3. The average growth of the construction sector was 7 times higher than mining and quarrying sector growth during 2001 – 2010 i.e. 1.08 % and 0.15 respectively. Minimum growth in construction and mining sector were -9.07 % and -8.47 % respectively in 2006 due to global financial crunch that can be seen in Figure 3. It can also be observed from Figure 3 that construction sector growth pattern is same throughout the study period, and has constant variance, while the mining and quarrying sector has not any particular pattern and variance is also not constant.
Table 3: Growth Comparisons

<table>
<thead>
<tr>
<th>Sectors</th>
<th>Mean</th>
<th>Variance</th>
<th>Min. value</th>
<th>Max. value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>1.08</td>
<td>41.53</td>
<td>-9.07</td>
<td>11.78</td>
</tr>
<tr>
<td>Mining &amp; Quarrying</td>
<td>0.15</td>
<td>20.16</td>
<td>-8.49</td>
<td>10.54</td>
</tr>
</tbody>
</table>

Data source: Department of Statistics Government of Malaysia

Table 4: Employment Contributions

<table>
<thead>
<tr>
<th>Sectors</th>
<th>Mean</th>
<th>Variance</th>
<th>Min. value</th>
<th>Max. value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>9</td>
<td>0.1</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Mining &amp; Quarrying</td>
<td>0.49</td>
<td>0.01</td>
<td>0.28</td>
<td>0.55</td>
</tr>
</tbody>
</table>

Data source: Department of Statistics Government of Malaysia

**Pearson Correlation Analysis**

Table 5 below is comprised on the correlation matrix of the concerned variables data series. A Pearson correlation test was conducted to examine the relationship between the sectors and found that weak negative relationships exist between construction and mining and quarrying sector during study period i.e. – 0.26 on the bases of available quarterly data series.

Table 5: Correlation Matrix

<table>
<thead>
<tr>
<th></th>
<th>Construction</th>
<th>Mining, quarrying</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>1</td>
<td>-0.26</td>
</tr>
<tr>
<td>Mining, quarrying</td>
<td>-0.26</td>
<td>1</td>
</tr>
</tbody>
</table>

Data source: Department of Statistics Government of Malaysia

**Comparison of Major Economic Indicators**

The comparison of major macroeconomic indicators output, employment, contribution to GDP and growth of the sectors during the study period are shown in Table 6. The annual average contribution to GDP and output of mining and quarrying sector were 2.65 times more than the construction sector, however employment contribution of construction sector was 22 times and growth was 5 times higher than the mining and quarrying sector during study period.

Table 6: Major Economic Indicators Comparison (ANNUAL BASES)

<table>
<thead>
<tr>
<th>Description</th>
<th>Construction Sector</th>
<th>Mining and quarrying sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output in (RM million)</td>
<td>15202</td>
<td>40687</td>
</tr>
<tr>
<td>Employment (%)</td>
<td>9</td>
<td>0.4</td>
</tr>
<tr>
<td>Contribution to GDP (%)</td>
<td>3.43</td>
<td>8.99</td>
</tr>
<tr>
<td>Growth %</td>
<td>2.27</td>
<td>0.49</td>
</tr>
</tbody>
</table>

Data source: Department of Statistics Government of Malaysia

**Series Stationarity Results**

The basic requirement of Granger causality test is stationarity of data series to avoid bias estimation [12]. This implies that the unit root test should be conducted for concerned variable data series. The two well-known unit root tests ADF and PP used under this study to examine null hypothesis that there is a unit root problem in the data series. The above mentioned equation 3 and equation 4 are used for...
these tests. The results of the preferred tests are shown in Table 7. Both series LCONS and LMINQ had unit root problems at level, however ADF and PP tests rejected the null hypothesis at all conventional level of significance 1%, 5% and 10%. Both tests ADF and PP tests suggested that there is no unit root problem in the data series at first difference and series are integrated order 1 i.e. I(1). This implies that there is a possibility of stable long run equilibrium relationship between the sectors.

Table 7: Stationarity (Unitroot) Test Results

<table>
<thead>
<tr>
<th></th>
<th>DF test at level intercept with trend</th>
<th>ADF test (first difference) intercept with trend</th>
<th>PP test (first difference) intercept with trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>LCON</td>
<td>-0.926</td>
<td>-6.764***</td>
<td>-6.983***</td>
</tr>
<tr>
<td>LMINQ</td>
<td>-2.836</td>
<td>-8.535***</td>
<td>-8.740***</td>
</tr>
</tbody>
</table>

Mackinnon critical value for rejection null hypothesis at 1%, 5%, and 10% level of significance intercept with trend are -4.190, -3.519 and -3.190 respectively. (*** denotes rejection null hypothesis at 1% sig. Level)

Granger Causality Results

ADF and PP tests have suggested that the only first differenced data can be used in the Granger causality model. This model does not only suggest that the two variables have linkage but also informs of the direction of link or relationship whether the concerned variables have unidirectional (one way effect), bidirectional (mutual influence) or have no linkage (do not affect each other). The results of Granger equations are summarized in Table 8 below.

Reject $H_0$: LMINQ does not Granger cause LCONS, at all conventional level of significance 1%, 5% and 10%, since F statistic value is greater than F critical. P value also confirming it as probability is less than all conventional levels of significance. Therefore must accept the alternate hypothesis $H_1$: LMINQ is Granger cause LCONS. However in reverse situation we failed to reject null hypothesis $H_0$: LCONS does not Granger cause LMINQ, since the F estimated is less than F critical and P value is greater than all levels of significance. So we reject the alternate $H_0$: LCONS is Granger cause of LMINQ.

Table 8: Granger Causality Test Results

<table>
<thead>
<tr>
<th>Null hypothesis</th>
<th>Lag order</th>
<th>F statistic</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>LMINQ does not Granger cause LCONS</td>
<td>2</td>
<td>12.165***</td>
<td>0.0001</td>
</tr>
<tr>
<td>LCONS does not Granger cause LMINQ</td>
<td>2</td>
<td>2.170</td>
<td>0.1300</td>
</tr>
</tbody>
</table>

*** denotes rejection of null hypothesis at 1% significance level

Thus it can be concluded that the mining and quarrying sector of Malaysia has impact on construction sector of Malaysia while causality model does not find strong evidence to show that the construction sector has effect on mining and quarrying sector of Malaysia. There is a unidirectional relationship between construction and mining and quarrying sector of Malaysia. Furthermore lag order 2 indicates the construction sector takes two quarters to absorb the shock received from Mining and quarrying sector of Malaysia.

CONCLUSION

Mining and quarrying and construction sectors play a very essential and effective role in the economic and social development of Malaysia. The two sectors are key component of industrialization of Malaysia as they have strong backward and forward linkage with other sectors of Malaysian economy. Mining and quarrying sector outputs are widely used in construction sector directly and also used as input for producing many building materials like cement, plastic, rubber, steel bars and sheets, gravel, marbles, etc. However, analysis depicts that there is a negative weak relationship between the two sectors. The Granger causality analysis shows that there was a unidirectional relationship between construction and mining and quarrying sector during the study period 2001-2010. The mining and quarrying sector output has significant effect on the construction sector output, but construction sector output does not have significant effect on mining and quarrying sector. The lag order of causality shows that the construction sector takes 2 quarters (6 months) to respond to shock received from mining and quarrying sector of Malaysia. The results of the study are informative and useful for ministries of sectors, policy makers and interested parties of the sectors.

LIMITATION

The result and analysis of the study captured only last two decades data (1991-2010) due to time and financial constraints. The result will be satisfied when all other factors remain constant.

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