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Rapid Economic Growth and Natural Gas Consumption Nexus: Looking forward from Perspective of 11th Malaysian Plan

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Abstract. The present study investigates the relationship between economic growth and energy consumption by incorporating CO₂ emissions, natural gas consumption and population in Malaysia. Annual data and F-bound test and granger causality have applied to test the existence of long run relationship between the series. The results show that variables are cointegrated for long run relationship. The results also indicate that natural gas consumption is an important contributing factor to energy demand and hence economic growth in case of Malaysia. The causality analysis highlights that the feedback hypothesis exists between economic growth and energy consumption. While, conservative hypothesis is validated between natural gas consumption and economic growth which implies that economic growth will push natural gas consumption policies in future. This study opens up new direction for policy makers to formulate a comprehensive natural gas policy to sustain environment for long span of time in case to achieve 11th MP targets.

Keywords: Economic Growth; Energy Consumption; CO₂ Emissions; Natural Gas Consumption; Population; Malaysia.

1. Introduction
There is close interaction between economic growth and energy consumption with pace of development. Due to increase energy consumption the resources are depleting and resulting in environmental challenges. In recent years, natural gas pipeline development is driven by market supply and demand. It has estimated that roughly 70% of natural gas flows across the globe are transported to market destinations within the country of production. While an additional 20% flows cross international borders through pipelines, and nearly 10% is moved to market destinations as liquefied natural gas (LNG). Total natural gas consumption is expected to grow at 18% annually between 2007 and 2035. The key end-use sector that is driving continued growth in natural gas demand is the electric power sector, in which natural gas has largely replaced oil and is successfully competing with coal [1]. Also, the growth of the renewable energy is enhancing due to Cross-State Air Pollution Rule, which leads to tradeoffs between the fuels used for electricity generation. For the past years during 2000 to 2012, electricity generation from natural gas-fired plants rose more than doubled due to fuel switching [2], [3]. The increasing demand of natural gas is relatively linked to electricity generation process. The fact is that natural gas...
generates relatively less CO\textsubscript{2} emissions than other fossil fuels e.g. coal. With this objective, many countries are exploring the options for better use of natural gas as an alternative energy source [4, 5].

In the Southeast Asian market as a net key exporter of LNG to global markets is also facing various challenges. For example, in case of Indonesia and Malaysia, due to geographical mismatch between the location of gas resources and demand has created the situation in which they are simultaneously importers and exporters of LNG [6]. Specifically in Malaysia, the fuel mix for power generation relies heavily on natural gas and coal. The share of coal and natural gas consumption for electricity generation recorded an annual growth rate 16.3% and 7.5% for the (1992-2013) period respectively [7]. Looking various renewable energy policies it has highlighted by [8] that the 10th Malaysia Plan (10MP) focused on attaining a sustainable level of economic growth that will enable the country to attain a developed nation status by 2020. They suggested that natural gas consumption has an indirect effect to the Malaysian economic growth but there is need of efficient exploitation of natural gas reserves of the country to meet future demand. Taking into consideration these policies, the objective of current paper is to look ahead the natural gas planning in coming years for fuel mix and emission reduction. According to the above discussion, this study raises the further question of what could be the contributions of natural gas consumption towards boosting the Malaysian economic growth prospects to aid in the attainment of the 11th Malaysian Plan. The growth hypothesis asserts that energy consumption is vital in economic growth both direct, as an input in the production process and indirectly, as a complement to labor and capital inputs. Moreover, this hypothesis suggests that an increase in economic growth causes an increase in energy consumption [9], [10], [11], [12], [13]. There are some studies used time series and panel data analysis in natural gas consumption perspective such as: [14], [15] for Taiwan; [16] for US; [17] for Iranian economy; [18] for US, [4] panel of 67 countries, [19] for the G7 countries; [20] for Bangladesh and [21] for Pakistan. Furthermore, [22] reinvestigated the relationship between natural gas consumption and economic growth Malaysia for the 1971–2012 period. They discovered natural gas consumption, foreign direct investment, capital formation and trade openness have positive influence on economic growth in Malaysia.

The above discussion clearly indicates that there is still room of research on the relationship between natural gas consumption and economic growth not only in the existing literature but also in case of Malaysia. So, this study is a good effort to fill up the gap in the existing literature by taking into consideration various policy perspectives. The rest of the paper is organized as follows: section 2 states data and methodological framework; section 4 discusses the empirical results; and the last section concludes the paper with policy implications.

2. Data Source and Methodology

The present study aims to investigate the relationship between economic growth and energy consumption while incorporating CO\textsubscript{2} emissions, natural gas consumption and population. We follow the methodological framework of aggregate growth model like [23], [24], [25], and [26] to examine the relationship between economic growth, energy consumption, CO\textsubscript{2} emissions, natural gas consumption and population. Annual time series data from 1980 to 2013 for above variables have been obtained from the [27], [28].The cointegration approach, the ARDL bounds testing approach developed by [29] is used to explore the existence of long-run equilibrium relationship between the variables. This approach has several advantages [30], [31]. By using the appropriate order, it is possible to simultaneously correct the serial correlation in residuals and the problem of endogenous regressors [32]. We have transformed all the series into logarithmic form as shown in Eq. (1).

\[
\Delta Y_t = \alpha + \sum_{s=1}^{p} \beta_s \Delta Y_{t-s} + \sum_{i=1}^{q} \beta_{i} \Delta E C_{t-i} + \sum_{t=1}^{q} \beta_{t} \Delta L N G_{t-t} + \sum_{i=1}^{q} \beta_{i} \Delta P O P_{t-i} + \lambda Y_{t-1} \\
+ \lambda_{1} \Delta E C_{t-1} + \lambda_{2} \Delta L N G_{t-1} + \lambda_{3} \Delta L N G_{t-1} + \lambda_{4} \Delta P O P_{t-1} + \mu_t
\]

Equation (1) presents two segments of results. The first part indicates the short run relationship such as \( \beta_s \); and second \( \lambda_s \) to explore the long run associations among the variables in the current study.
Lastly, we have applied multivariate Granger Causality test to check the direction among research variables (Eq. 2).

\[
\begin{bmatrix}
\Delta Y \\
\Delta E C \\
\Delta L C O_2 \\
\Delta L N G \\
\Delta L P O P
\end{bmatrix}
= 
\begin{bmatrix}
\alpha_1 \\
\alpha_2 \\
\alpha_3 \\
\alpha_4 \\
\alpha_5
\end{bmatrix} 
+ \sum_{s=1}^{d} \begin{bmatrix}
\beta_{11} & \beta_{12} & \beta_{13} & \beta_{14} & \beta_{15} \\
\beta_{21} & \beta_{22} & \beta_{23} & \beta_{24} & \beta_{25} \\
\beta_{31} & \beta_{32} & \beta_{33} & \beta_{34} & \beta_{35} \\
\beta_{41} & \beta_{42} & \beta_{43} & \beta_{44} & \beta_{45} \\
\beta_{51} & \beta_{52} & \beta_{53} & \beta_{54} & \beta_{55}
\end{bmatrix} \begin{bmatrix}
\Delta Y \\
\Delta E C \\
\Delta L C O_2 \\
\Delta L N G \\
\Delta L P O P
\end{bmatrix}_{t-s} 
+ \begin{bmatrix}
\mu_1 \\
\mu_2 \\
\mu_3 \\
\mu_4 \\
\mu_5
\end{bmatrix} + \phi_1 E C T_{t-1} + \phi_2 + \phi_3 + \phi_4 + \phi_5
\]  

(2)

3. Empirical Results

Augmented-Dickey-Fuller (ADF) is used to test the unit root properties of the variables. It finds that all series contain unit root problem at their levels, \(I(0)\), and stationary at 1st difference \(I(1)\). The calculated F-statistics is 8.33 which is greater than upper critical bound at 1% level, provided by [33]. The study highlights that the long-run results are robust, these findings are presented in Table 1 and they show that natural gas has negative and significant impact on economic growth. The empirical result display that a 1% increase in energy consumption will lead to increase the economic growth by 0.41% in long run and 0.50% in short run and both of them are significant at 1% level of significance. In addition, a 1% increase in emissions is positively linked with economic growth at 0.42% and 0.179% in long and short run respectively. Whereas, the natural gas consumption shows a decline with economic growth in long run by 0.1019%, but positive in the short run. Also, the study discuss that how population was found to have a positive and significant link with economic growth as 1.19% in long run and 0.067% in short run. These findings are consistent with [34] and [35], who highlighted this relationship in Malaysian economy.

Table 1: Long run and Short run coefficients.

| Dependent Variable = \(LY\) | Short run Coefficients |
|-----------------------------|------------------------|
| Variable | Coefficient | T-Statistic | Probability | Variable | Coefficient | T-Statistic | Probability |
| Constant | -11.350 | -5.467 | 0.000 | Constant | 0.007* | 6.052 | 0.000 |
| LEC | 0.413 | 2.324 | 0.038 | \(\Delta E C\) | 0.505 | 2.122 | 0.041 |
| LCO\(_2\) | 0.422 | 8.871 | 0.000 | \(\Delta C O_2\) | 0.179 | 3.147 | 0.004 |
| LNG | -0.102 | -6.089 | 0.000 | \(\Delta N G\) | 0.007 | 0.212 | 0.834 |
| LPOP | 1.199 | 7.663 | 0.000 | \(\Delta P O P\) | 0.066 | 2.0714 | 0.046 |
| ECM \(_{t-1}\) | -0.096** | -2.177 | 0.036 |

Furthermore, the lagged error term ECM \(_{t-1}\), confirms the significant long-run relationship between the variables (at 5% level). Moreover, Figure 1, shows that there is bidirectional causality between economic growth and energy consumption; energy consumption and natural gas and economic growth and population. Whereas, unidirectional causality from economic growth to natural gas consumption; energy consumption to \(C O_2\) emissions and population to \(C O_2\) emissions.

![Figure 1: Granger Causality Result.](image)

Note: \(\longrightarrow\) shows bidirectional, \(\rightarrow\) unidirectional and \(*\cdot\cdot\cdot*\) no causality.

4.Conclusion and Policy implications

The paper investigated the relationship between economic growth and energy consumption by using \(C O_2\) emissions, natural gas consumption and population in a multivariate framework in case of Malaysia over the 1970–2013 period. It has applied the ARDL bounds testing approach for testing the
stationary properties by unit root tests and explores short and long run relationship. The direction of causality between the variables is investigated by applying the Granger causality. The findings depict that economic growth pushed energy demand and CO2 emissions but declines natural gas consumption in the case of Malaysia. These findings propose various policy implications in this context. It is very important to have careful planning for renewable energy (RE) as an alternative energy source. It can further enhance to support the continuous increase of energy demand complemented with nominal efforts on energy efficiency measures. Furthermore, various efforts will be undertaken to ensure security of natural gas supply which is significant to the reliability of electricity supply. Key efforts include increasing natural gas capacity through the laying of additional pipelines and installing another receiving terminal in Kerteh, Terengganu to receive additional gas volume from Malaysia-Thailand Joint Development. One of the factors contributing to the unbalanced energy mix is the highly subsidized natural gas, which is the preferred fuel for the electricity subsector as it incurs the least cost. It has proposed in 11MP that due to increased natural gas demand in near future it is important to develop future market price for industries, secondly, there is fuel switching plan and lastly look new resources to fill the gas demand and supply gap [36].

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