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# Infrastructure development and economic growth in Malaysia: An ARDL approach

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**Abstract**
The aim of the study is to analyze the impact of infrastructure development on economic growth in Malaysia for the period of 1983 – 2014. The six main infrastructure indicators are utilized to develop the infrastructure index by using the principal component analysis (PCA). The infrastructure development index is used together with other control variables such as labour force, fixed capital formation and human capital to estimate the long run relationship between independent variables and economic growth. The Autoregressive distributed lag (ARDL) model and the variance decomposition (FEVD) are performed to identify the existence of the long run relationship among all variables and to examine the effect of shocks to the economic growth, respectively. Results obtained indicate that there exists a long run relationship between infrastructure and economic growth for the period under study. The coefficient of expenditure on health and education, investment and infrastructure are 0.02, 0.423 and 0.113, respectively. The results indicate that infrastructure development has a significant positive contribution to economic growth in Malaysia. The forecast error variance decomposition shows that in the long run the infrastructure transitory shock significantly explains 22.44 percent of fluctuations in the economic growth. Therefore the government needs to continuously review and implement a relevant policy to ensure that the infrastructure facilities are adequate and improved as well as the human capital development to stimulate economic growth in Malaysia.

**Keywords:** infrastructure, time series data, economic growth, autoregressive distributed lag (ARDL)

## Introduction

As recognized by many scholars, infrastructure is the main driving force of economic development of a country. A good infrastructural services will raise efficiency of several components of production and thus productivity. In the literature, there are quite a number of studies that analysed the relationship between different infrastructural services and output or income. Put forward by several sources that the availability of adequate infrastructural facilities, becomes the pre-condition for sustainable economic and societal development (WDR, 1994; Bhatia, 1999) [5]. On the other hand a limited availability and low quality of infrastructure facilities may become an obstruction for a country's development (Klytchnikova and Lokshin, 2011) [16].

This study attempts to examine the importance of infrastructure in influencing the economic growth in Malaysia. The paper is structured as follows, section 2 is the brief overview of infrastructure development in Malaysia. Section 3 presents the literature review, followed by section 4, the theoretical framework. Sections 5 analyse the empirical results, and lastly, section 6 concludes.

## Infrastructure development in Malaysia: An overview

Since independence, the Malaysia government has made efforts and heavy investments in improving its infrastructures such as highways, railways, airports and others. In Malaysia Five Year Plans (MP1 to MP10), the allocation in development expenditure on infrastructure has increased continuously. Table 1 shows the infrastructure's share of development expenditure. During the Third Malaysian Plan, there was a substantial growth in the infrastructure's share of total development expenditure, from 12 % to 23%. The allocation for infrastructure expenditure increased up to the 7th Malaysia Plan; 80.9%. Then on the 8th Malaysian Plan and 9th Malaysia Plan, the allocation reduced to 66.6% and 58.2%, respectively.

**Table 1:** Public Development Expenditure on Infrastructure (RM million)

| | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|---|---|
| Public utilities[1] | 2244 | 2358 | 2795 | 2899 | 5286 | 6013 | 5519 | 3332 | 3432 |
| Transport | 7751 | 8500 | 9212 | 9450 | 8665 | 10140 | 10065 | 8152 | 8152 |
| Communication | 8 | 105 | 334 | 618 | 688 | 848 | 455 | 187 | 240 |
| Total Development Expenditure on Infrastructure | 10003 | 10963 | 12341 | 12967 | 14639 | 17001 | 16039 | 11671 | 11824 |
| Total Development Expenditure | 35807 | 40564 | 42847 | 49515 | 52792 | 46416 | 46932 | 42210 | 42222 |
| Infrastructure's % Share of Development Expenditure | 27.93 | 27.03 | 28.80 | 26.19 | 27.73 | 36.63 | 34.17 | 27.65 | 28.00 |

**Notes:** [1] mainly electricity and water supply
***Source:*** Department of Statistics.

## Literature Review

There has been a long-standing body of empirical work analyzing the interrelationship between infrastructure development and economic development. The diversity of methods used in the literature to study the relationship, including production function, cross country regressions, cost functions and growth accounting. Output, productivity or regional inequality are usually use as the dependent variable. And for the independent variables a proxy such as some measure of public capital or physical indicators are commonly employed. Many works have been carried out to study the relationship between different physical infrastructural services and the per capita income or production. Among others are Aschauer (1989, 1990) [3]; Binswanger (1990) [6]; Ahmad and Hossain (1990) [2]. Aschauer (1989, 1990) [3] in his study used a time series and cross section data from 58 states. Results obtained indicate a significant positive relationship between per capita income and density of paved roads. Similarly, Binswanger (1990) [6] in his study found that the road network and road density have a strong relationship with the agricultural output. Meanwhile Ahmad and Hossain (1990) [2], in their study on Bangladesh, found that the quality road increased the usage of fertiliser.

Meanwhile, Fernald (1999) [14] used industry-level analyses emphasizing the network and geographic location aspects of infrastructure to examine how road building in the US impacted on the productivity of 29 industries. His findings indicate that road building in the US prior to 1973 did improve productivity of the US, albeit benefiting vehicle-intensive industries disproportionately. Post-1973, when the road network had already been completed the findings do not indicate any

The bulk of growth accounting-based frameworks have found empirical support for a positive link between infrastructure and growth (Straub, 2008) [23]. Most studies, find positive and significant contributions of infrastructure to growth. In particular, telecommunications infrastructure is consistently found to be a significant growth factor. Meanwhile Esfahani and Ramirez (2003) [11], in their study apply a cross-country regression over the period of 1965-95 to a structural model of infrastructure and growth. The results of their study showed that the contribution of infrastructure services to economic growth is substantial and it exceeds the cost of the provision of those services.

Nevertheless, it should be noted that different forms of infrastructural services jointly affect the per capita income/production. They are mutually interdependent, therefore it is appropriate to include the various components of the infrastructure and compute them together as a composite index of infrastructure.

Meanwhile, study done by Riaz (1997) [19] discussed the pattern of telecommunications infrastructure development and services in the late-1980s in Malaysia. The development of telecommunications infrastructure plays a key role in the development of Malaysian economy. Lee (2011) [17] in his study, provide an insights of how the infrastructure sector contributes to the Malaysian economy development. Likewise, Suleiman and Albiman (2014) [24] analysed empirically the inter-relationship between tourism, trade, infrastructure and economic growth in Malaysia using an annual time series data over the period of 1999-2010. Empirical results reveal that trade has a substantial long-term effects on the economic growth of Malaysia. Generally, the study validates that infrastructure development, trade, tourism, and economic growth in Malaysia interact and strengthen each other either directly or indirectly during the period under the study.

## Theoretical Framework

The empirical studies on the contribution of capital investment on economic development are primarily founded on the production function framework. Assuming a generalized Cobb-Douglas production function and extending the neoclassical growth model to include infrastructure stock as an additional input of the production function along with capital investment and labour. The production function then can be written as

$$Y_t = f(K, L_t, I_t) \quad (1)$$

where
$Y_t$ = Gross output
K = Total Capital
$L_t$ = Labour Force
$I_t$ = Infrastructure

To assess the impact of human capital on growth, public expenditure on health and education are used in this study. The next equation is estimated to take apart the impact of infrastructure economic growth.

$$\ln GDP_t = \alpha_i + \beta_{it} + \beta_1 lnK_t + \beta_2 lnL_t + \beta_3 lnI_t + \beta_4 lnPE_t + e_t \quad (2)$$

where
*GDP* = *real gross domestic product*
K = Total Investment
I = Infrastructure Index
L = Labor Force
PE = per capita real public expenditure on education and health.

The expected signs of $\beta 1, \beta 2, \beta 3, \beta 4$ is > 0.

The composite index of major infrastructure indicators is estimated using the principal component analysis and used to analyze its effect on economic growth.

## Methodology

Data and Sources

This paper uses annual data for the period of 1983 to 2014. All variables are expressed in logs. All series of data used in this study are collected from the World Development Indicators (WDI), the Economic Planning Unit (EPU) and the Statistics Department of Malaysia.

The five variables used in this paper are defined as follows:

1. Real gross domestic product (RGDP) is a measure of total output of the Malaysian economy. RGDP is expressed in RM.
2. Total Investment is proxy by gross fixed capital formation.
3. Infrastructure Index is calculated by employing the principal component analysis and use six main

infrastructure indicators, which are per capita electricity power consumption, per capita energy use, telephone line (fixed line and mobiles) per 1000 population, rail density per 1000 population, air transport, freight million tons per kilometre and paved road as percentage of total road.

4. Labour force.
5. Per capita real public expenditure on education and health.

**Estimation Method**

The Augmented Dickey Fuller (ADF) test is performed to identify whether all variables are stationary and to determine the orders of integration of the variables. Using the autoregressive distributed lags (ARDL), the existence of a long run relationship among variables is identified. Finally, the forecast error variance decomposition (FEVD) is also performed to examine the effects of shocks to the dependent variables. It actually identifies how much of the forecast error variance for any variable in a system is explained by innovations to each explanatory variable over a series of time horizons.

**Empirical Results**

Unit Root Tests

The existence of unit roots and the order of integration of all variables are determined using the ADF tests. The results are presented in Table 2. From the table, all variables are non-stationary in levels, but stationary in first difference, or I (1).

**Table 2:** ADF Unit Root Test

| Variables | Level | | First Difference | |
|---|---|---|---|---|
| | Lag | ADF Statistics | Lag | ADF Statistics |
| GDP | 2 | -1.454067 | 2 | -4.476237* |
| K | 2 | -2.594848 | 2 | -3.799179** |
| L | 2 | -2.194574 | 2 | -9.704927*** |
| PE | 2 | -3.137864 | 2 | -7.008493*** |
| I | 2 | -2.217538 | 2 | -4.708372** |

(***, **,*) denotes the statistically significant level of 1%, 5% &10%

**ARDL Tests**

The autoregressive distributed lag (ARDL) method is then employed to find out the long run relationship among the relevant variables. As shown in Table 3, the value of F statistics (F = 6.12) exceeds the upper bound critical value (4.35) at the 5% level, therefore, establishing a long run relationship between GDP and all independent variables.

**Table 3:** ARDL Bound Test

| Test Statistic | Value | k |
|---|---|---|
| F-statistic Critical Value Bounds Significance | 6.119078 | 4 |
| | I0 Bound | I1 Bound |
| 10% | 2.45 | 3.52 |
| 5% | 2.86 | 4.01 |
| 2.5% | 3.25 | 4.49 |
| 1% | 3.74 | 5.06 |

The long run elasticity are then estimated using ARDL model. As presented in Table 4, all coefficients have the expected sign and are statistically significant. As anticipated, the coefficient of expenditure on health and education, investment, is positive signifying statistically significant positive impact on GDP. The coefficient of expenditure on health and education is around 0.02, which the value is lower than the elasticity of infrastructure index. Meanwhile, the long run elasticity of investment is 0.423 and the coefficient of infrastructure is 0.113. In general, the results indicate that infrastructure development has a significant positive contribution to growth in Malaysia. Likewise human capital such as expenditure on health and education contributes substantially to economic growth. Infrastructure facilities as represented by the infrastructure index, also indicates an important contribution to development. The results obtained are in line with Easterly and Rabelo (1993) [8]; Calderon and Serven (2003); Esfahani and Ramires (2003) [7, 11].

**Table 4:** ARDL Long Run Estimation Results

| Variables | Long run coefficients (ARDL) |
|---|---|
| Constant | 15.14 (0.000) |
| LogI | 0.113 (0.043) |
| LogPE | 0.018 (0.200) |
| LogL | 0.002 (0.559) |
| LogK | 0.423 (0.007) |
| Adj.$R^2$ | 0.98 |
| D-W stat | 0.70 |
| Hansen J stat P-value | 2.08 (0.148) |
| Order of ARDL | (1, 0, 0, 0, 0) |
| Serial Correlation LM Test | 1.199 (0.319) |
| Heteroskedasticity Test | 1.90 (0.130) |

From Table 5, the VDC shows the significant role played by K, PE and I in accounting for fluctuations in GDP. At 2 year horizon, the fraction of GDP forecast error variance attributable to variations in the K, PE and I are 22.10%, 8.22% and 0.05% respectively. Thus, the infrastructure transitory shock is considered as a minor driving force of the economic growth in the short run. However, in the long run the infrastructure transitory shock significantly explains 22.44 percent of fluctuations in the economic growth.

**Table 5:** Decomposition of Ten Years Forecast Error Variance (%)

| Percentage of forecast error variance in years | GDP | K | PE | I |
|---|---|---|---|---|
| % of Forecast Error Variance in Growth GDP Explained by | | | | |
| 1 | 100 | 0 | 0.00 | 0.00 |
| 2 | 69.61 | 22.10 | 8.22 | 0.05 |
| 3 | 59.70 | 31.79 | 7.54 | 0.95 |
| 4 | 42.93 | 40.27 | 8.26 | 8.52 |
| 5 | 32.94 | 46.97 | 8.39 | 11.68 |
| 6 | 25.52 | 50.15 | 9.47 | 14.84 |
| 7 | 20.90 | 51.86 | 10.32 | 16.90 |
| 8 | 17.63 | 52.30 | 11.03 | 19.02 |
| 9 | 15.40 | 52.33 | 11.39 | 20.86 |
| 10 | 13.79 | 52.16 | 11.60 | 22.44 |

Notes: Order of Var selection is 2 based on AIC criteria.

## Conclusion

This paper investigates the relationship between infrastructure development and economic growth in Malaysia. Utilizing a time series data for the period of 1983 – 2014, the autoregressive distribution lag (ARDL) model is applied to estimate the effect of infrastructure on economic growth. The infrastructure development index is developed using the principal component analysis (PCA). Together with other variables such as labour force, gross fixed capital formation and human capital which is proxy by the government expenditure on education and health, its effect on economic growth is estimated. Results obtained reveal that there exists a long run relationship between all variables involved. The infrastructure development has a significant positive impact on economic growth in Malaysia with the coefficient of 0.11. Furthermore, the forecast error variance decomposition (FEVD) shows that even though in a short run the infrastructure transitory shock being a minor driving force to the economic growth, in the long run the infrastructure transitory shock significantly explains 22.44 percent of fluctuations in the economic growth. Therefore the government should continuously improve the infrastructure facilities as well as the human capital formation to achieve a sustainable economic growth.

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