

Public Health Spending and GDP per Capita in Malaysia: Does the Lucas Critique Apply?

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Abstract: This study re-examined the public health expenditure and GDP per capita nexus, applying the super exogeneity test developed by Engle and Hendry (1993). We utilised time series annual data for Malaysia from 1970 to 2013, during which the country had witnessed a noticeable increase in Gross Domestic Product and various regime shifts, namely, the “Malaysian Incorporated” policy in 1983, Asian financial crisis in 1998 and the Global financial crisis in 2008. The results of super exogeneity test show that public health expenditure is weakly exogenous and in variance to the policy shifts that have taken place, and therefore it is super exogenous for the parameters of the estimated model. In other words, health expenditure from the public source of financing promotes GDP per capita improvement and Lucas critique does not hold in the case of Malaysia.

Keywords: GDP per capita, public health expenditure, superexogeneity
JEL classification: C49, I15

1. Introduction

The role of the government in times of recession was advocated by John Maynard Keynes during the economic downturn of the 1930s. This stand was challenged by the classical economists who insisted on self-adjusting mechanisms in the labour market to force the economy back to equilibrium in the long-run. Keynesian theory offers an expansionary fiscal policy to avoid long-term recession due to rigidities in the labour market. The neoclas-

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The authors are very grateful to staff of the Economics Department, Faculty of Economics and Management, Universiti Putra Malaysia for their guidance and support.

sical growth models (i.e., endogenous and exogenous growth models) have been utilised in modern empirical analysis to model the relationship between government spending and economic growth (Feder, 1983; Landau, 1983). In addition, Diamond (1989) suggests that the government should know the relative contribution of the sectors that drive economic growth so as to protect social sectors such as education, health and housing from suffering. In most developing countries, fiscal deficits have been blamed for many of the problems that emerged in the 1980s. Some of these issues are: high indebtedness (debt crises), increasing inflation and unemployment. Wagner (1893) and during the Great Depression of the 1930s, Keynes (1936) aroused the interest of researchers in development economics on the role of government spending in economic development.

Empirical analysis of the impact of aggregate government spending on long-run economic growth has been explored in economic literature since the launch of "The General Theory of Employment, Interest and Money" by Keynes right after the Great Depression of the 1930s. A few among these studies attempted to find the relationship between government expenditure and economic growth (Feder, 1983; Landau, 1983; Kormendi & Meguire, 1985; Grier & Tullock, 1989; Romer, 1986; Barro, 1990, Barro, 1991; Levine & Renelt, 1992; Devarajan, Swaroop & Zou, 1996; Sala-i-Martin, 1997). These studies provide mixed results on the relationship between government expenditure and economic growth and most of the studies dwell on cross-section analysis. On the other hand, the empirical findings for disaggregated government spending with a particular focus on health expenditure favour a unidirectional causality between health expenditure and economic growth with causality running from economic growth to health spending. Some of the studies pointed out this critical relationship between health expenditure and Gross Domestic Product (GDP) (Culyer, 1990; Murthy & Ukpolo, 1994; Hansen & King, 1996; McCoskey & Selden, 1998; Gerdtham & Lothgren, 2000). More recently, Wang (2011) asserts that in the long-run, an increase in health care expenditure will enhance growth and vice versa.

However, some methods have been tried by economic researchers to verify the causal relationship between health care expenditure and output per capita. These methods have been questioned by modern day econometricians. Most of the traditional time series methods have been criticised because a large percentage of the studies assumed that the data is stationary. As explained by Chang, Liu & Caudill (2004), non-stationary data will produce a spurious regression result. Although, more powerful tests have emerged to analyse economic data, the problem with data manipulation still lingers. In recent times, a number of studies have applied better methods to overcome the problem of non-stationary data and the level of integration of the data. For data integrated at the same level, the VECM and VAR have been applied and a more recent technique is the Autoregressive Distributed Lags (ARDL) proposed by Pesaran, Shin and Smith (2001) and Narayan (2005) for large and small samples respectively.

With regard to the relationship between government expenditure on health and economic growth, Nketiah-Amponsah (2009) emphasised the role of government spending on health and infrastructure. According to him, making the following policy recommendation is said to have a positive and significant impact on growth in Ghana: "The government of Ghana should practise a mixed policy of expenditure cutbacks and switching. While aggregate government expenditure inhibits economic growth, the expenditure allocations to health and infrastructure promote growth. It is, therefore, imperative that expenditure

allocations is increased to pro-poor interventions in health, infrastructure and education, while maintaining defence expenditure or reducing it slightly" (Nketiah-Amponsah, 2009, p. 495). This statement might be highly misleading if there exists any regime or policy shift and the Lucas critique holds. Lucas (1976) argued that shifts in economic policy affects the economy because agents in the economy are forward rather than backward looking and adapt their expectations and behaviour to the new policy. For this reason, Lucas concluded that reduced form econometric models cannot provide useful information about the actual consequences of alternative policies because, the structure of the economy will change when policy changes, which make the estimated parameters in the reduced form models non-constant (Linde, 2001).

Many empirical studies have investigated the relationship between public health expenditure and output using different econometric techniques without paying attention to the possibility of regime shifts and how that may affect the findings. On the other hand, the super exogeneity test has been used to examine whether regime shifts may change how policy affects the economy. For example, Gregoriou, Hunter and Wu (2009) investigated the relationship between the real economy and stock returns in the case of US using super exogeneity. Similarly, Issler and Lima (2000) examined the sustainability of public debt and government spending in Brazil.

The question of causality has been a long-standing debate. However, it has become critical for economists and policy makers to estimate well-specified models for policy purposes. To arrive at a robust conclusion for policy control, two available structural approaches to causality have been suggested. The first is proposed by Simon (1953) and revised by Hoover (1988; 2001) and the second is the super exogeneity idea developed by Engle, Hendry and Richard (1983) and Engle and Hendry (1993). The concept of causality is synonymous to super exogeneity (Ericsson et al., 1998) and testing for super exogeneity is more direct in testing control causality compared to the traditional methodology.

This study aims to examine the impact of government health spending on GDP per capita in Malaysia from 1970 to 2013. In this paper, we apply the well-known test for super exogeneity to examine whether increasing public health expenditure leads to improvement of output per capita in the long-run. In other words, in order to make policy suggestions in relation to public health expenditure, it is necessary to test whether the Lucas critique exists. This paper is organised as follows: Section 2 provides an overview of the Malaysian economy, Section 3 explains the methodology, while Section 4 shows the data used in the study and the results, and finally, Section 5 draws the conclusion of the study.

2. Overview of the Malaysian Economy, 1960-2013

This section provides a summary of the Malaysian economy and the development indicators from 1960 – 2013. The economy of Malaysia after the independence grew at an average of 5.4% with tin-mine, rice production and rubber cultivation being the major foreign exchange earners. Further growth in GDP was witnessed between the years 1971 – 1980 but the share of agriculture as a percentage of GDP at constant prices fell from 40.2% in 1955 to 21% at the end of 1980 (Samudram, Nair & Vaithilingam, 2009). The contribution of the primary sector was enormous but was not consistent due to the fluctuations in the commodity market, which caused instability in the economy. The continuous fluctuations in the economy forced the government to diversify the agricultural sector to include co-

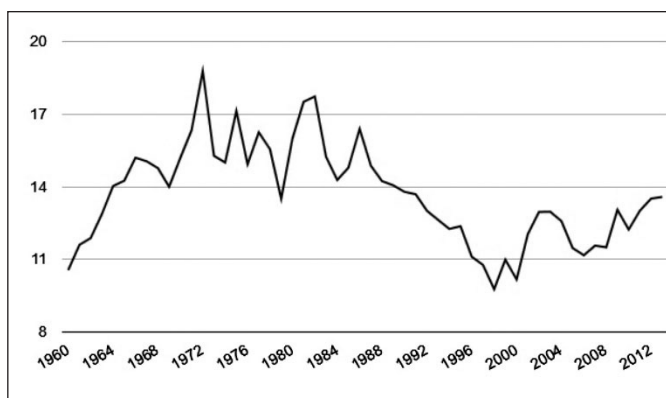


Figure 1. Government spending as percentage of GDP
 Source: TheGlobalEconomy.com, The World Bank

coa, oil palm, timber and new varieties of rice. Another sector that witnessed a boost was the manufacturing sector that contributed 30.94% in 1999 from a bottom low of 7.86% in 1961.

The government provided incentives for foreign investment in Malaysia during the 1970s resulting in increased participation in economic activities during the same period.

The graph above shows government expenditure as a percentage of GDP from 1960 to 2012. It is obvious that the government was involved in financing the growth process of the Malaysian economy from independence as their contribution increased from 10.56% in 1960 to 17.73% in 1982. Subsequently, the share of government spending as a percentage of GDP began to fall as a result of a policy shift, necessitated by the occurrence of a huge public sector deficit

The ‘Malaysian Incorporated’ policy was introduced in 1983 to woo the private sector into participating intensively in the economy with the government providing the necessary framework and enabling environment. The participation of the private sector in the economy during the 1980s saw government spending as a percentage of GDP falling up to the year 2004 when a slight increase was noticed. The drive towards a sustainable economy through the private sector commenced in the 1980s and gave the government the opportunity to focus more on other sectors of the economy that provide public goods like education, health care, transport and defence. The share of agriculture in total expenditure declined due to the expansion in the manufacturing sector. Government expenditure on social sectors such as health witnessed a significant increase from 6.5% in 1970 to 7.7% in 2005 as a share of total government spending.

3. Causality between Public Health Expenditure and GDP Per Capita

Testing for super exogeneity requires the specification of the conditional and marginal models of the variables of interest. The joint distribution of GDP per capita and public health expenditure (PHE) can be decomposed into conditional and marginal models as follows:

$$F_J(GDP_t, PHE_t | X_t; \lambda) = F_C(GDP_t | PHE_t, \lambda_{1t}) F_M(PHE_t | X_{2t}; \lambda_{2t})$$

where F_j , F_C and F_M are the joint distribution of GDP_t and PHE_t , the conditional (distribution) model of GDP_t given PHE_t , and the marginal (distribution) model of PHE_t , respectively. The X_t represents other variables besides including lags of GDP_t and PHE_t , while, λ_t , λ_{1t} and λ_{2t} are parameter vectors that may not be constant over time. According to Engle et al. (1983), weak-exogeneity exists if the conditional model can be estimated without loss of information about λ_{1t} , if the marginal model has been neglected. In addition, if λ_{1t} remains constant or invariant to the changes in λ_{2t} , then PHE_t is said to be super exogenous.

Engle and Hendry (1993) proposed a method to test for super exogeneity with the null hypothesis that PHE_t is super exogenous or the Lucas critique does not exist, for the parameters in the conditional model:

$$GDP_t = \beta PHE_t + \delta X_{1t} + e_t \tag{1}$$

where X_{1t} is a vector of other explanatory variables and e_t is the random error term with zero mean and constant variance. Assuming the set of variables X_t , which, includes X_{1t} , then the distribution of the marginal model can be described as follows:

$$PHE_t = \vartheta X_{2t} + v_t \tag{2}$$

where X_{2t} contains the past values of PHE_t and GDP_t , besides, other conditioning variables. The construction of X_{2t} is assumed to allow for regime shifts in the data generating process for PHE_t . Lastly, to test for super exogeneity, we use the F-test for $\hat{\vartheta}_i$ and $\hat{\vartheta}_i^2$ ($\hat{\vartheta}_i = \hat{\vartheta}_i^2 = 0$), besides testing for parameter stability in the conditional model using CUSUM of squares and recursive coefficients of the conditional model tests. If we fail to reject the null hypothesis of the super exogeneity test, then we can confidently make policy recommendations because PHE_t is not subject to the Lucas critique, but is super exogenous.

3.1 The Estimation of the Conditional and Marginal Models

To estimate the relationship between public health expenditure, we consider the following neoclassical growth model:

$$\ln GDP_t = \beta_0 + \beta_1 \ln PHE_t + \beta_2 \ln SER_t + \beta_3 \ln K_t + \beta_4 \ln PG_t + \mu_t \tag{3}$$

where $\ln GDP_t$ is the natural log of GDP per capita, $\ln PHE_t$ is the log of public health expenditure, $\ln SER_t$ is the log of secondary school enrolment, $\ln K_t$ is the log of gross capital formation, $\ln PG_t$ is the log of population growth, and μ_t is the error term, which is assumed to be uncorrelated over time. From Equation (3), we can model our conditional and marginal models as follows:

$$F_C (GDP_t/PHE_t/X_{1t}) = \Delta \ln GDP_t = \theta_0 + \sum_{i=1} \alpha_i \Delta \ln GDP_{t-i} + \sum_{i=0} \gamma_i \Delta \ln PHE_{t-i} + \sum_{i=0} \vartheta_i \Delta \ln SER_{t-i} + \sum_{i=0} \delta_i \Delta \ln K_{t-i} + \sum_{i=0} \rho_i \Delta \ln PG_{t-i} \tag{4}$$

$$F_M (PHE_t/X_{2t}) = \Delta \ln PHE_t = \phi_0 + \sum_{i=1} \sigma_i \Delta \ln PHE_{t-i} + \sum_{i=0} \varphi_i \Delta \ln GDP_{t-i} + \sum_{i=0} \tau_i \Delta \ln R_{t-i} + \sum_{i=0} \lambda_i \Delta \ln K_{t-i} + \pi_1 \text{DUM1} + \pi_2 \text{DUM2} + \pi_3 \text{DUM3} \tag{5}$$

where $\ln R_t$ and $\ln P65_t$ represent total revenue and population 65 years and above as a

percentage of total population, respectively. The marginal model is the public health expenditure function, which is assumed to a large extent affected by the lagged values of $\ln GDP_t$, total government revenue and the percentage of elderly out of the total population. The DUM1, DUM2 and DUM3 are dummy variables to capture the impact of the policy shifts of the 'Malaysian Incorporated' national policy that was introduced in 1983, the Asian financial crises in 1998, and also the 2008 global financial crises; DUM1 = 1 if year ≥ 1983 , DUM2 = 1 if year ≥ 1998 and DUM3 = 1 if year ≥ 2008 .

4. Data and Empirical Findings

To estimate the conditional and marginal equations, the study used annual Malaysian data for the period 1970 to 2013. The period covers four recent decades, during which time Malaysia witnessed rapid economic growth rate and noticed improvements in public health expenditure. The variables required to estimate Equations (3) and (4) are real GDP per capita, public health spending, secondary school enrolment, gross capital formation, and population growth rate. Equation (5) has more additional variables such as total revenue and population 65 years and above as a percentage of the total population. The variables secondary school enrolment, gross capital formation and population growth rate were obtained from the World Development Indicator database (2015), while, real GDP per capita, public health expenditure and total revenue were retrieved from Ministry of Finance Malaysia.

4.1 Unit Root, Cointegration and Weak-Exogeneity Tests

The time series data explained in the previous section are tested for unit root, using the Augmented Dickey-Fuller (1979) ADF test and Phillip-Perron (1988) PP test, to identify the integrating order of the variables. After identifying the order of integration among the variables, the cointegration test becomes necessary. Johansen (1988) cointegration approach, which requires all variables to be $I(1)$, is used to verify whether there is a long-run relationship between variables. If the long-run equilibrium relationship exists among variables, then the JJ (Johansen & Juselius, 1990) weak-exogeneity test can be performed to verify that our variable of interest is weakly exogenous and we can also estimate the long-run effect of public health expenditure and the other variables explained in Equation (3) on output per capita.

The findings of ADF and PP tests are reported in Table 1. The variables were tested for the presence of unit root in level and the first difference with an intercept and with intercept and time trend. Both tests indicate that all variables have unit roots in level since the null hypothesis cannot be rejected in the case of intercept and intercept and time trend. On the other hand, the ADF and PP tests reveal that variables are stationary after the series are converted to the first difference, which is an indication that all the variables are integrated of order $I(1)$.

Table 2 presents the results of the Johansen cointegration test. The trace statistics and max-eigen statistics values reveal that variables are cointegrated, and thus the long-run equilibrium relationship between variables exists. Having established the long-term association, the long-run equation and weak-exogeneity test can then be performed. Table 3 shows that public health expenditure is weakly exogenous and positively influences GDP per capita; it shows that a 1% increase in public health expenditure is associated with

Table 1. Unit root test

Variable	ADF		PP	
	Constant	Constant and trend	Constant	Constant and trend
$\ln GDP_t$	0.474	-3.061	-0.870	-3.153
$\ln PHE_t$	-1.384	-2.651	-1.476	-3.136
$\ln SER_t$	-2.319	-2.628	-2.299	-2.681
$\ln K_t$	-2.141	-2.439	-2.256	-2.225
$\ln PG_t$	-0.570	-2.204	0.384	-0.842
$\ln R_t$	-2.208	-3.517 ^c	-2.229	-2.031
$\ln P65_t$	3.335	1.283	2.207	0.357
1 st difference				
$\Delta \ln GDP_t$	-4.890 ^a	-4.891 ^a	-6.649 ^a	-6.596 ^a
$\Delta \ln PHE_t$	-5.236 ^a	-5.263 ^a	-6.673 ^a	-6.689 ^a
$\Delta \ln SER_t$	-5.572 ^a	-5.729 ^a	-5.576 ^a	-5.709 ^a
$\Delta \ln K_t$	-5.709 ^a	-5.684 ^a	-5.711 ^a	-5.678 ^a
$\Delta \ln PG_t$	-1.079	-3.599 ^b	-1.975	-2.303
$\Delta \ln R_t$	-5.382 ^a	-5.927 ^a	-5.393 ^a	-5.931 ^a
$\Delta \ln P65_t$	-3.111 ^b	-4.364 ^a	-3.168 ^b	-4.343 ^a

Note: a, b and c indicate significance at 1%, 5% and 10% respectively. The lag length and bandwidth are chosen according to AIC and Newey-West automatic using Bartlett kernel, respectively.

Table 2. Cointegration test

The null hypothesis	Trace statistics	Max-Eigen statistics
$r = 0$	141.3 ^a	66.61 ^a
$r \leq 1$	74.71 ^b	38.37
$r \leq 2$	36.34	23.47
$r \leq 3$	12.87	11.84
$r \leq 4$	1.022	1.022

Note: a and b indicate significance at 1% and 5%, respectively. The lag length (3) is according to AIC.

a 0.28% increase in GDP per capita in the long-run. Also, secondary school enrolment ($\ln SER_t$) and capital ($\ln K_t$) are positive and significant factors that explain the changes in income per capita. However, the growth rate of population ($\ln PG_t$) is negatively associated with GDP per capita. The existence of cointegration allows us to estimate the conditional model in the form of the error correction model (ECM) (Metin, 1998).

4.2 The Results of the Conditional and Marginal Models

Table 4 presents the findings of the conditional and marginal models. Both the conditional and the marginal equations are estimated allowing for four lags following Hendry and Richard's (1982) general to specific procedure. We estimated two conditional models (A) and (B), with the only difference between them being that model (B) contains the

Table 3. Long-run relations and weak exogeneity test

Null hypothesis	Long-run relation (<i>p</i> -value)	Adjustment speed (<i>p</i> -value)
$\ln GDP_t$	1	-1.0651 ^a (0.412)
$\ln PHE_t$	0.283 ^a (0.022)	0.6739 (0.490)
$\ln SER_t$	0.434 ^a (0.109)	0.0658 (0.296)
$\ln K_t$	0.4066 ^a (0.034)	1.4132 ^c (1.006)
$\ln PG_t$	-0.7257 ^a (0.088)	-0.0560 ^b (0.026)

Note: a, b and c indicate significance at 1%, 5% and 10% respectively. Between parentheses are the standard errors. The lag length (3) is according to AIC.

Table 4. The estimation of conditional and marginal models

The conditional model (A) for $\Delta \ln GDP_t$	$\Delta \ln GDP_t = 0.056^a - 0.378^a \Delta \ln GDP_{t-2} - 0.122 \Delta \ln PHE_t - 0.037 \Delta \ln SER_t + 0.520^b \Delta \ln SER_{t-4} + 0.239^a \Delta \ln K_t - 0.862^b \Delta \ln PG_{t-4}$ $R^2 = 0.54, LM(4) = [0.98], ARCH(4) = [0.70], JB = [0.73],$ $RESET = [0.25]$
The conditional model (B) for $\Delta \ln GDP_t$	$\Delta \ln GDP_t = 0.052^a - 0.332^b \Delta \ln GDP_{t-2} - 0.045 \Delta \ln PHE_t - 0.164 \Delta \ln SER_t + 0.425^c \Delta \ln SER_{t-4} + 0.236^a \Delta \ln K_t - 0.601 \Delta \ln PG_{t-4} - 0.213^c ECT_{t-1}$ $R^2 = 0.58, LM(4) = [0.94], ARCH(4) = [0.53], JB = [0.74],$ $RESET = [0.88]$
The marginal model for $\Delta \ln PHE_t$	$\Delta \ln PHE_t = 0.229^a - 0.391^b \Delta \ln PHE_{t-2} - 0.670^b \Delta \ln GDP_{t-2} + 0.292^c \Delta \ln R_t + 0.484^b \Delta \ln R_{t-1} + 0.384^b \Delta \ln R_{t-2} - 0.250^c \Delta \ln R_{t-4} - 5.724^a \Delta \ln P65_{t-1} + 0.010 DUM1 - 0.047 DUM2 + 0.123^a DUM3$ $R^2 = 0.51, LM(4) = [0.09], ARCH(4) = [0.27], JB = [0.45],$ $RESET = [0.67]$

Note: a, b and c indicate significance at 1%, 5% and 10% respectively. For serial correlation and heteroskedasticity tests, the number of lags is indicated in parentheses. Values in brackets are *P*-values.

long-run information captured by the error correction term extracted from Equation (3). In the short-run, $\Delta \ln PHE_t$ and $\Delta \ln SER_t$ are negative but insignificantly related to $\Delta \ln GDP_t$ in both models (A) and (B). However, $\Delta \ln SER_{t-4}$ is found to be positive and significant in explaining $\Delta \ln GDP_t$ in the two conditional models. In the same vein, $\Delta \ln K_t$ is found to be a positive and significant explanatory variable. Nevertheless, $\Delta \ln PG_{t-4}$ is negative and significant in model (A), but it becomes insignificant after including the ECT-1 in model (B). Additionally, the error correction term shows that any disequilibrium is adjusted by 21% annually. The diagnostic tests indicate that the estimated conditional models (A) and (B)

are efficient and correctly specified. The stability tests CUSUM of squares and recursive coefficients for the conditional models (A) and (B) are shown in the Appendix (Figures 1-4). More specifically, the CUSUM of squares shows the stability of the parameters, since the line lies between the 5% significance level. Furthermore, with two-standard errors, the recursive coefficients indicate minor unstable movements particularly at the first period but become stable in the later periods. The outcomes of these stability tests indicate that the conditional models (A) and (B) are stable during the period of estimation.

Estimation of the marginal model is presented in Table 4. The results reveal that income affects public health spending only with lags, since $\Delta \ln GDP_{t-2}$ is negative and significant, which implies that any improvement in GDP does not affect PHE_t immediately, but with lags. The total government revenue is found to be an important element that affects public health expenditure contemporaneously as well as with lags. The aging population $\Delta \ln P65_{t-1}$ has a significant lag effect on $\Delta \ln PHE_t$. The included dummy variables DUM1 and DUM2 are found to have no impact on the marginal model of $\Delta \ln PHE_t$, which indicates that the Asian crises and the policy of 'Malaysia Incorporated' are not the reasons for a policy shift. However, the dummy variable DUM3, which captures the global financial crises of 2008, is positive and statistically significant at 1%. This indicates that the marginal model contains unstable parameters due to the structural break caused by the 2008 financial crises. The marginal analysis passed the serial correlation, heteroskedasticity, model specification tests, and the error term is normally distributed.

4.3 Super Exogeneity Test Results

To test for superexogeneity of PHE_t for the parameters of the $F_c(GDP_t/PHE_t, X_{1t})$, we estimated \hat{v}_t and \hat{v}_t^2 into Equation (4) to get the following:

$$\ln GDP_t = F_c(GDP_t/PHE_t, X_{1t}) + d\hat{v}_t + e\hat{v}_t^2 \quad (6)$$

where \hat{v}_t and \hat{v}_t^2 are extracted from the marginal model explained in Equation (5), which contains a policy shift during the period of estimation. The insignificant of d implies that PHE_t is weakly exogenous for the parameters of the conditional model. If d and e are jointly insignificant, then PHE_t is said to be super exogenous for the parameters of the conditional model. In addition, the stability of the conditional model also implies the super exogeneity of the variable, and PHE_t control causes GDP_t .

Table 5 shows the results of the super exogeneity test for models (A) and (B). The coefficients of \hat{v}_t and \hat{v}_t^2 are both insignificant and the joint F-test p -values are 0.69 and 0.76, for models (A) and (B) respectively. Thus, the parameters of the estimated conditional model of output per capita are stable within the period of estimation from 1970 to 2013. The results indicate that PHE_t is super exogenous for the parameters of the conditional model. However, the findings show that $\Delta \ln PHE_t$ is insignificant in explaining $\Delta \ln GDP_t$ in the short-run; it can therefore be inferred that public health expenditure control causes GDP per capita in the long-run. The diagnostic checking displays that the model is efficient and correctly specified since it passes autocorrelation, heteroskedasticity, normality and misspecification tests.

The results of this study emphasise the critical importance of health expenditure to improve the level of human capital by making individuals healthier and consequently increase their level of productivity. Equally, healthy individuals have the ability to learn and

Table 5. Super exogeneity test

Variable	Model (A)	Model (B)
Constant	0.046 ^c (0.017)	0.040 ^b (0.165)
$\Delta \ln GDP_{t-2}$	-0.335 ^b (0.129)	-0.247 ^c (0.129)
$\Delta \ln PHE_t$	-0.080 (0.101)	0.028 (0.106)
$\Delta \ln SER_t$	-0.009 (0.261)	-0.187 (0.257)
$\Delta \ln SER_{t-4}$	0.571 ^b (0.221)	0.448 ^b (0.214)
$\Delta \ln Kt$ 0.221a(0.071)	0.204 ^a (0.067)	
$\Delta \ln PG_{t-4}$	-0.805 ^b (0.342)	-0.436 (0.361)
	0.041 (0.149)	-0.021 (0.142)
	1.241 (1.790)	1.222 (1.678)
ECT_{t-1} -0.294 ^b	(0.132)	
	$R^2 = 0.51$, F-joint = [0.69], LM(4) = [0.90], ARCH(4) = [0.92], JB = [0.83], RESET = [0.33]	$R^2 = 0.58$, F-joint = [0.76], LM(4) = [0.75], ARCH(4) = [0.87], JB = [0.56], RESET = [0.88]

Note: a, b and c indicate significance at 1%, 5% and 10% respectively. Standard errors are in parentheses. For serial correlation and heteroskedasticity test, number of lags is in parentheses. Values in brackets are *p*-values.

improve their educational attainment. Another important finding is that the impact of human capital in the form of education is positively and significantly related to GDP per capita. In addition, the output per capita reacts positively to any increment in the capital. However, population growth rate tends to reduce the output per capita in the long-run.

5. Conclusion

As mentioned previously, the purpose of this study is to determine the long-run relationship between public health expenditure and output per capita. Additionally, the super exogeneity test proposed by Engle and Hendry (1993) is used to examine whether the Lucas critique applies in the context of public health spending and GDP per capita nexus in Malaysia. The study also considered the possibility of a long-run cointegrating relationship among variables. Furthermore, the human capital neoclassical growth model was adopted in order to have reasonable explanations on the possible relationship between human capital in the form of health and education.

The results reveal that variables tend to move together in the long-run, and the estimated long-run model and weak exogeneity test show that public health expenditure is weakly exogenous and stimulates output per capita. Similarly, human capital in the form of education is found to have a positive impact on GDP per capita. These findings emphasise the role played by human capital in stimulating economic growth in the country, since a 1% percent increase in public health expenditure and secondary school enrolment is associated with 0.28% and 0.43% increase in GDP per capita, in the long-run, respectively. In agreement with theoretical expectation, the impact of capital is found to be positive and significant in explaining GDP improvement in Malaysia. On the contrary, the population growth rate tends to reduce GDP per capita during the period of estimation, because it is

found to be negatively significant.

This study contributes to the existing literature by testing for super exogeneity of public health expenditure to GDP per capita. It also provides evidence that the Lucas critique hypothesis does not hold in the case of public health spending and output per capita nexus in Malaysia. The super exogeneity and weak exogeneity tests confirm that public health expenditure is weakly exogenous. More importantly, the joint F-test failed to reject the null hypothesis of the Engle and Hendry (1993) test. Therefore, public health expenditure is super exogenous to the parameters of the conditional model. The marginal model tells us that the reverse causality cannot hold, since GDP per capita is one of the explanatory variables, which appears to have only a lag effect on public health spending. With the finding that public health expenditure control causes output per capita, the conclusion can be drawn is that there exists a unidirectional causal relationship running from public health expenditure to GDP per capita, in contrary to Samudram et al. (2009) which found a bi-directional causality between health expenditure and gross national product (GNP) in the case of Malaysia. One of the possible explanations is the failure to account for super exogeneity of health expenditure. Although the structural break of the 1998 Asian financial crisis was considered, they did not take into account the Malaysian Incorporated national policy in 1983 and the global financial crisis of 2008.

The findings of this study appear to contradict the argument of the Lucas critique that any regime shift will change the way policies affect the economy. Health care policy is important for upkeeping the health system in the country. This may be supported by the fact that the public health system has been the backbone of the delivery of health care in the country and has contributed significantly to the improvement of health outcomes of the population over the previous decades (Wan et al., 2015). Therefore, public health expenditure remains invariant to various regime shifts with respect to GDP per capita. [As shown in Figure 5 in the Appendix, government expenditure on health is rapidly increasing over the last decades, indicating the absence of structural changes in the data.] Although the super exogeneity test enables us to evaluate the relevance of the Lucas critique, it is not robust to any unknown endogenous regime changes.

From the findings of this study, some policy recommendations can be made. The government of Malaysia should at least maintain or improve its health expenditure and attempt to verify its sources of funding to improve income per capita in the long-run. Increasing health expenditure could help to expand the coverage of health services to include the poor, which has a positive consequence on individual health status and total productivity, and thus economic growth. The total revenue received by the government is a major factor leading to a higher government expenditure, therefore, diversifying the sources of tax and non-tax revenues is central to improving and sustaining government spending on health. Correspondingly, the other form of human capital (education), beside capital appears to be equally important for long-run economic performance.

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Appendix

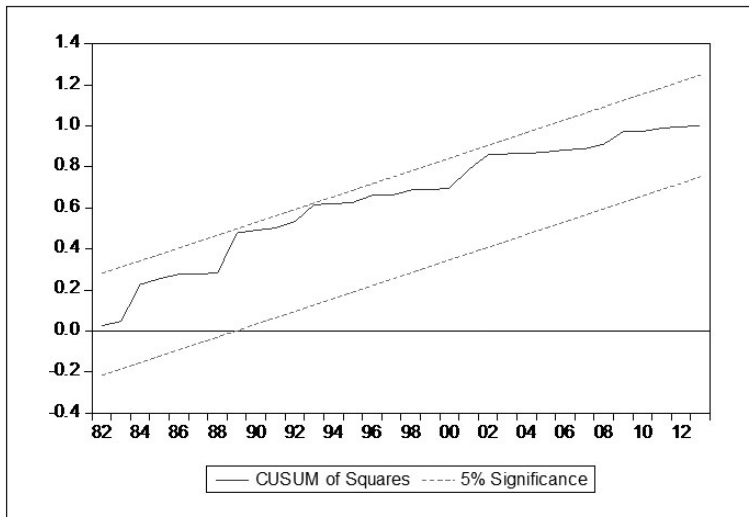


Figure 1. CUSUM of squares of the conditional model (A)

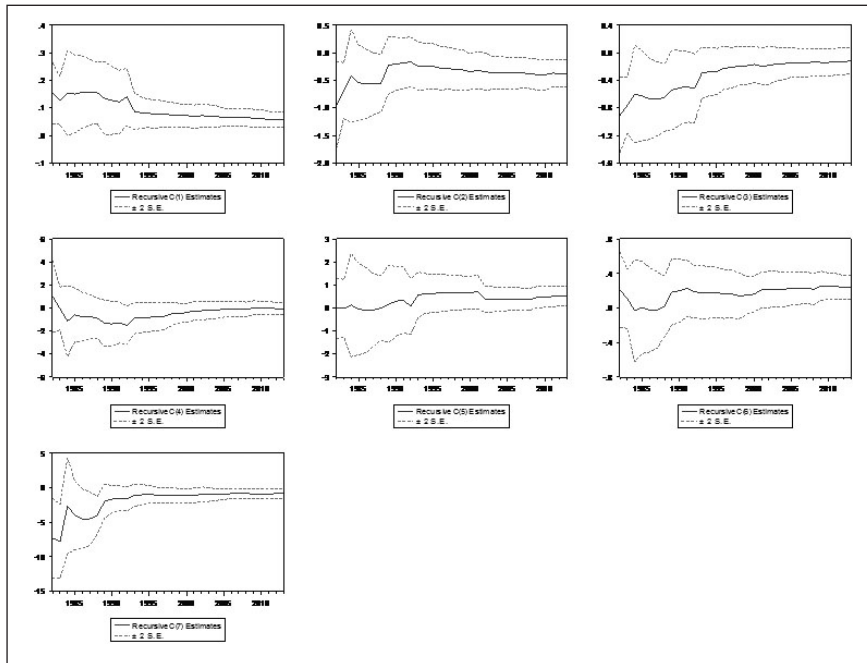


Figure 2. Recursive coefficients of the conditional model (A)

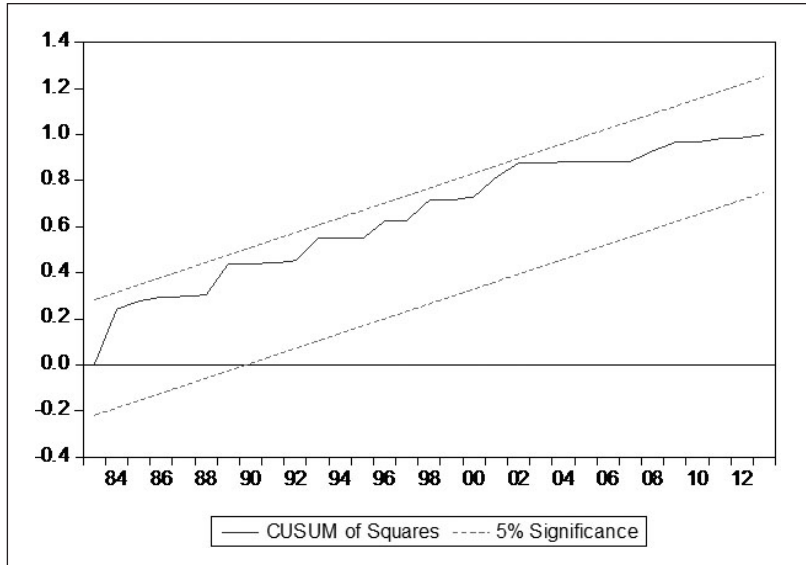


Figure 3. CUSUM of squares of the conditional model (B)

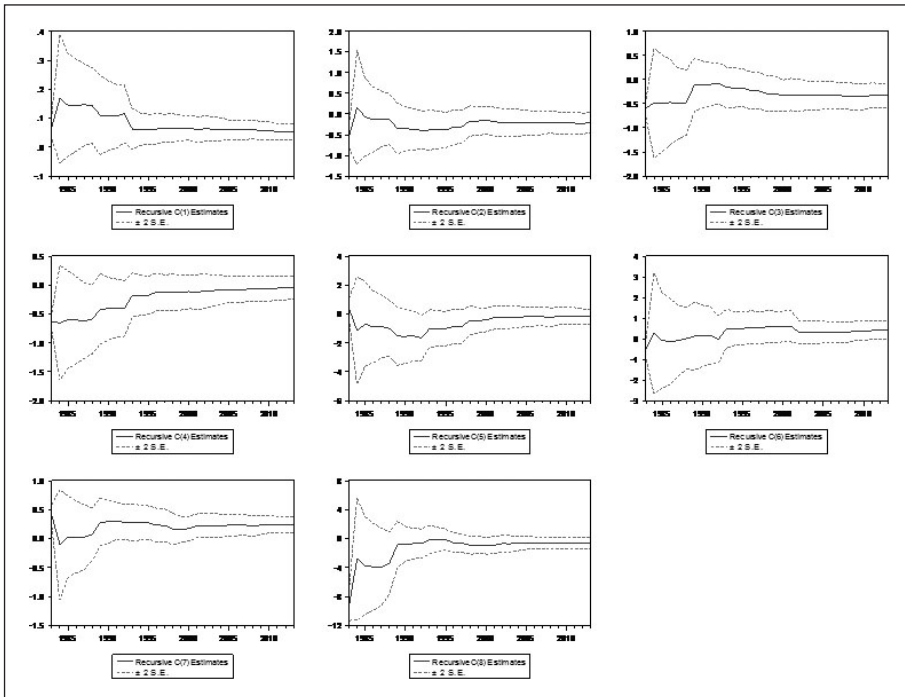


Figure 4. Recursive coefficients of the conditional model (B)

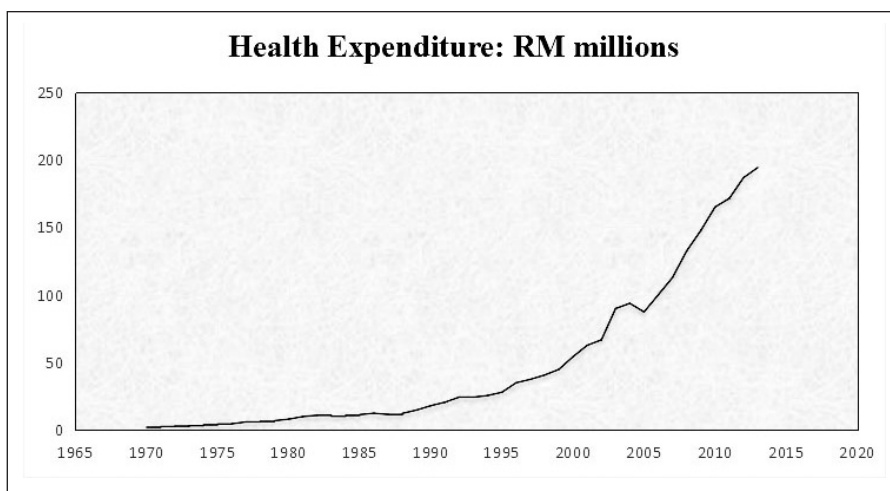


Figure 5. *Public health expenditure*
Source: Department of Statistics Malaysia.