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The Causal Relationship between Health and Education Expenditures in Malaysia

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Abstract. *A major macroeconomic policy in generating economic growth is to encourage investments on human capital such as health and education. This is because both health and education make significant contribution to increasing productivity of the labour force which ultimately exerts a positive effect on raising output levels. A question that arises is whether investments on health and education have a causal relationship and if so, what is the directional causality? The objective of this study is to examine the causal relationship between health and education expenditures in Malaysia. This study covered annual data from 1970 to 2007. Using Granger causality as well as Toda and Yamamoto MWALD causality approaches, this study suggests that education Granger-causes health expenditure in both the short run and long run. The findings of this study implied that the Malaysian society places preference on education expenditure rather than health. This preference is not unexpected as generally, an educated and knowledgeable society precedes a healthy one. Before a society has attained a relatively higher level of education, it is less aware of the importance of health. Thus, expenditure on education should lead expenditure on health.*

Keywords: causality; education; health; Malaysia; MWALD.

JEL Codes: H51, H52, I00, J24.
REL Codes: 13B, 13C.

1. Introduction

One of the major macroeconomic policies in generating long run economic growth in a nation is to encourage investments on human capital such as health and education (Mushkin, 1962, Barro, 2001, Pereira, Aubyn, 2009). It can be reasonably assumed that investments in health and education will lead to better health and a higher level of education standard in the long term. Higher levels of health and education are factors contributing to increasing productivity and efficiency of the labour force which ultimately exert a positive effect on raising output levels. The economic literature also suggests that there is a strong positive relationship between health and education (Ross, Wu, 1995). Moreover, various theoretical explanations have also been provided by many researchers towards a better understanding of this relationship. For example, Grossman (1972) opined that education affects health by enhancing the efficiency in health production. Kenkel (1991) documented that education has a positive effect on health via the allocation of health input because well-educated people are more likely to choose healthy life-styles. Hartog and Oosterbeek (1998) looked at the effects of different levels of education on health. They found that only relatively higher-educated people are aware of the importance of health. Cowell (2006) also found that people with higher levels of education tend to engage in healthy life-styles. In contrast, Arendt (2005), who examined the effect of education on health in Denmark using panel data, found that the effect of education on health is inconclusive. In Netherlands, Groot and Maassen van den Brink (2007) found that the effect of education on health is positive and large. However, they cautioned that this significant effect does not imply that it will result in the efficient allocation of resources when they are channelled into education in order to encourage a healthy society. Most of these studies are based on the assumption that there is unidirectional causality from education to health and have discounted the possibility that the reverse relationship can occur.

Analysing the direction of causality between health and education is important as it provides the necessary and important information for policy planners when they formulate appropriate macroeconomics policies, in particular on the relationship between health, education and economic growth. If the causality is from education to health, for example, it may result in changes in individual choices made in favour of health relative to other products and services. Moreover, such a directional causality will result in increased dissemination of knowledge and information about the true effects of other factors on health. For instance, a more educated community will have a better knowledge on the dangers of smoking or the ill effects of consuming fatty food. As both education and health contribute to economic growth

(Aka, Dumond, 2008), and the possible causality from education to health, investments in education and health are essential in the process of development.

A review of existing literature reveals that empirical studies on the relationship between health and education mostly focused on developed countries. Papers on the relationship between health and education for developing countries are relatively limited. Apart from that, many of the early empirical studies have been performed using inappropriate econometric methodologies, as they did not take into consideration the time series properties of the data used (for example, Ross, Wu, 1995, Arendt, 2005, Silles, 2009). According to Granger and Newbold (1974), the estimated regression results are spurious if the series used are non-stationary and are not cointegrated. For this reason, the results provided by the aforementioned empirical studies are questionable and should be used with caution.

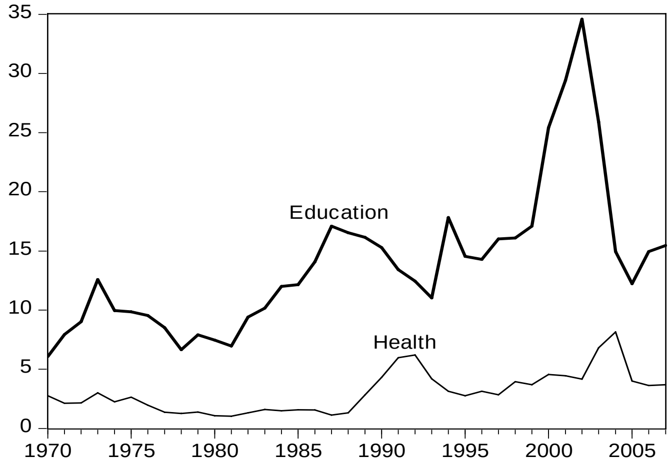

Figure 1. *Proportion of government development expenditure on education and health (percent)*

Figure 1 shows the expenditure on education and health as a proportion of total government development expenditure in Malaysia for the period 1970 to 2007. It is evident that both types of expenditure increased steadily during the period. However, it is also clear that the proportion of government development expenditure on education is consistently higher than that of health expenditure, implying that the government has recognised the relatively more important role of education in generating economic growth and development. It is aware of the fact that in order to create a stable and competitive economy, investments in human capital via education are essential. During the decade from 1981 to 1990, the proportion of total expenditure on education increased from 6.96 per cent to 15.29 per cent, while that on health rose from 1.07 per cent to 4.31 per cent.

The proportion of expenditures on education further increased from 13.43 per cent in 1991 to a peak of 34.57 per cent in 2002. This increasing pattern may be attributed to the implementation of the policy strategies that emphasised on the creation of knowledge-based economy (K-economy). In contrast, the proportion of expenditure on health decreased from 5.98 per cent to 4.20 per cent over the same period of 1991 to 2002. By 2008, however, the proportion of expenditure on education and health has stabilised to about 19 per cent and 5 per cent, respectively.

The purpose of this study is to empirically investigate the causal relationship between health and education expenditures in Malaysia within the Granger causality framework using yearly data from 1970 to 2007. More specifically, this study attempts to examine the empirical question of whether funds should first be spent on health or education. In reality, resources are limited and hence preferences and choices have to be set by all consumers, firms, government and policymakers during the process of allocation of the available resources so that an optimal outcome could be attained. Therefore, it is useful to establish empirically how the choice could be made. This study adds to the body of existing literature in three ways. First, the relationship between health and education for less developed countries is rarely studied. Thus, by investigating empirically such a relationship in Malaysia, which is a small and open developing economy, meaningful comparison can be made with the results from developed countries. Malaysia is an interesting economy to study because of its impressive growth record over the past few decades. Furthermore, the investment on human capital such as health and education expenditures also showed an increasing pattern over time. It is evident from Figure 1 that, as a proportion of total development expenditure, education expenditure far exceeded that of health.

Second, this study is an advantage over the existing literature since we first undertake a thorough examination on the stationarity properties for each series before proceeding to the estimation of the causal relationship between education and health expenditures. This is to avoid possible spurious estimation problems. In this respect, we employed various unit root tests to affirm the degree of integration for each series. This procedure for testing unit roots is absent in most existing literature. The unit root tests employed by this study are Augmented Dickey-Fuller (ADF) (Dickey, Fuller, 1979, 1981), Phillips-Perron (PP) (Phillips-Perron, 1988), Kwiatkowski-Phillips-Schmidt-Shin (KPSS) (Kwiatkowski et al., 1992), Zivot and Andrews (ZA) (Zivot, Andrews, 1992) and Lumsdaine and Papell (LP) (Lumsdaine, Papell, 1997) tests. Third, we examine both the short and long run causal relationship of health and education by using Granger (1969) and Toda and Yamamoto (1995) causality procedures.

The remaining of this paper will be organised as follows. Section 2 will briefly discuss the data source and econometric techniques used in this study. Next, the empirical results and concluding remarks will be presented in Sections 3 and Section 4, respectively.

2. Data source and econometric techniques

2.1. Data source

The annual data of public expenditures on health and education for Malaysia are obtained from various issues of the *Economic Report* published by the Ministry of Finance, Malaysia, and the *Monthly Statistical Bulletins* published by Bank Negara Malaysia. The Consumer Price Index (CPI, 2000 = 100) was used to deflate the series to the real variables. Annual data have been used in this study because of the unavailability of higher frequency data (e.g., quarterly or monthly). Moreover, the use of annual data will also avoid the seasonal bias problems. The annual data covered the period 1970 to 2007. All data used in this study are in natural logarithm form.

2.2. Unit root tests

To examine the time series properties of data, we employ five sets of unit root tests. Apart from the conventional ADF, PP and KPSS unit root tests, this study will also employ the ZA and LP unit root tests with one and two structural breaks, respectively. As the conventional unit root tests were well defined in earlier literature, this study will only discuss the ZA and LP unit root tests.

Models A and C for one structural break ZA unit root test will be used to examine the order of integration for each series. Model A allows for a change in the intercept of the series, while Model C allows for changes in both the intercept and the slope of the trend of the series. The models used for testing are expressed as follows:

$$\text{Model A: } \Delta y_t = \kappa + \alpha y_{t-1} + \beta t + \theta_1 DU1_t + \sum_{i=1}^{k} d_i \Delta y_{t-i} + \xi_t \quad (1)$$

$$\text{Model C: } \Delta y_t = \kappa + \alpha y_{t-1} + \beta t + \theta_1 DU1_t + \gamma_1 DT1_t + \sum_{i=1}^{k} d_i \Delta y_{t-i} + \xi_t \quad (2)$$

where Δ is the first difference operator $\left(y_t - y_{t-1}\right)$, the error terms ξ_t are assumed to be normally distributed and white noise. As in the conventional ADF unit root test, we incorporate the Δy_{t-i} terms into the testing equations (1) and (2) so as to remove the autocorrelation problem of higher order between the error terms. The dummy variables are defined as: $DU1_t = 1$ and $DT1_t = t - TB1$

if $t > TB1$ and 0 otherwise. $TB1$, with $1 < TB1 < T$, where T is the sample size, denotes the time at which the structural break occurs. The optimal lag order (k) is determine by the "t-significance" method suggested by Hall (1994) and the breakpoint ($TB1$) is selected where the ADF t-statistic $t\left(\hat{\lambda}_{\inf}\right)$ is maximised in absolute term. In addition, the breakpoints search is carried out over the 70 per cent trimming region (0.15T, 0.85T), where T is the sample size.

Nevertheless, the ZA unit root test is particularly designed to handle one structural break. The power of the test is low when the estimated series is confronted with more than one structural breaks. For this reason, we apply the LP unit root test for two structural breaks to ascertain the order of integration for each series under investigation$\left[\ln EE,\ \ln HE_t\right]$. Corresponding to the ZA test, we estimate the following Models AA and CC for LP unit root tests:

$$\text{Model AA: } \Delta y_t = \kappa + \alpha y_{t-1} + \beta t + \theta_1 DU1_t + \psi_1 DU2_t + \sum_{i=1}^{k} d_i \Delta y_{t-i} + \varepsilon_t \quad (3)$$

$$\text{Model CC: } \Delta y_t = \kappa + \alpha y_{t-1} + \beta t + \theta_1 DU1_t + \gamma_1 DT1_t + \psi_1 DU2_t + \omega_1 DT2_t + \sum_{i=1}^{k} d_i \Delta y_{t-i} + \varepsilon_t \quad (4)$$

where $DU1_t = 1$ and $DT1_t = t - TB1$ if $t > TB1$ and 0 otherwise. Similarly, $DU2_t = 1$ and $DT2_t = t - TB2$ if $t > TB2$ and 0 otherwise. $TB1$ and $TB2$ represent the time at which the structural breaks one and two occur respectively, where $TB2 > TB1 + 2$. The optimal lag order (k) is determined by the "t-significance" method and the breakpoints $TB1$ and $TB2$ are selected where the ADF t-statistics $t\left(\hat{\lambda}_{\inf}\right)$ is maximised in absolute term. Finally, the GAUSS programming codes will be used to compute the ZA and LP unit root tests for one and two structural break(s), respectively.

2.3. Causality tests

In this study, we applied the Granger and MWALD causality tests to estimate the short and long run causal relationship between health and education expenditures, respectively.

2.3.1. Granger (1969) causality test

Since the standard Granger causality testing procedure has been widely used in earlier empirical studies, only a brief discussion is offered here. Causality in the Granger sense asserts that education expenditure causes health expenditure if the past values of education expenditure can be used to forecast health expenditure more accurately than just the past values of health expenditure. In order to apply the Granger causality test one must ensure that all the estimated variables in the VAR system must be stationary. As most of the macroeconomics series are *I*(1) processes (Nelson, Plosser, 1982), it follows that the VAR system with first differenced variables should be estimated. Therefore, the Granger causality testing equation for the short run causal relationship between health and education expenditures can be expressed as follows:

$$\begin{bmatrix} \Delta \ln HE_t \\ \Delta \ln EE_t \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix} + \begin{bmatrix} A_{11,1} & A_{12,1} \\ A_{21,1} & A_{22,1} \end{bmatrix} \times \begin{bmatrix} \Delta \ln HE_{t-1} \\ \Delta \ln EE_{t-1} \end{bmatrix} + \cdots + \begin{bmatrix} A_{11,k} & A_{12,k} \\ A_{21,k} & A_{22,k} \end{bmatrix} \times \begin{bmatrix} \Delta \ln HE_{t-k} \\ \Delta \ln EE_{t-k} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix} \quad (5)$$

where Δ is the first difference operator, $\ln HE_t$ and $\ln EE_t$ are the real health and education expenditures respectively and *k* is the optimal lag order. The errors $(\varepsilon_{1t}, \varepsilon_{2t})$ are assumed to be white noise and normally distributed. The Granger causality test is implemented by computing the χ^2-statistic on the lagged explanatory variables. From equation (5), $A_{12,k} \neq 0 \forall_k$ implies that there is causality running from education to health expenditures. On the other hand, health expenditure Granger-causes education expenditure, if $A_{21,k} \neq 0 \forall_k$ holds.

2.3.2. Modified Wald (MWALD) causality test

He and Maekawa (2001) argued that the *F*-statistics for Granger causality test often leads to spurious causality inference when one or both of the estimated series are non-stationary. Furthermore, due to the lower power of the test, the unit root test will always have a degree of uncertainty with respect to the order of integration. Owing to this problem, Toda and Yamamoto (1995) proposed a simple procedure (modified Wald – MWALD test) which involves the estimation of an augmented vector autoregression (VAR) model at the level irrespective of the order of integration. Thus, pre-testing of unit root is not required in this causality test. The test is conducted for variables at the level by adding an extra lag $(d_{\max})$ into the VAR system. This is to ensure that the asymptotic critical values can be applied when the test is conducted between the integrated variables. The $d_{\max}$ lag refers to the assumed maximum order of integration. Thus, the MWALD testing equation can be expressed as follow:

$$\begin{bmatrix} \ln HE_t \\ \ln EE_t \end{bmatrix} = \begin{bmatrix} \beta_1 \\ \beta_2 \end{bmatrix} + \begin{bmatrix} B_{11,1} & B_{12,1} \\ B_{21,1} & B_{22,1} \end{bmatrix} \times \begin{bmatrix} \ln HE_{t-1} \\ \ln EE_{t-1} \end{bmatrix} + \cdots + \begin{bmatrix} B_{11,k} & B_{12,k} \\ B_{21,k} & B_{22,k} \end{bmatrix} \times \begin{bmatrix} \ln HE_{t-k} \\ \ln EE_{t-k} \end{bmatrix} + \begin{bmatrix} B_{11,p} & B_{12,p} \\ B_{21,p} & B_{22,p} \end{bmatrix} \times \begin{bmatrix} \ln HE_{t-p} \\ \ln EE_{t-p} \end{bmatrix} + \begin{bmatrix} \xi_{1t} \\ \xi_{2t} \end{bmatrix} \quad (6)$$

In order to employ the MWALD test, we have to pre-specify the maximum order of integration $(d_{\max})$ for the series in the VAR system. Regarding the extra lag $(d_{\max})$ term, Dolado and Lütkepohl (1996) suggested using $d_{\max} = 1$ due to its best performance in their Monte Carlo study. In this respect, we use $d_{\max} = 1$ in our study. Similarly, the F-statistic is employed to examine the existence of causal relationship. From equation (6), $B_{12,k} \neq 0 \forall_k$ asserts that there is causality running from education to health expenditures; whereas the reverse causality running from health expenditure to education expenditure holds if $B_{21,k} \neq 0 \forall_k$.

3. Empirical results

The first step in our empirical analysis is an investigation of the order of integration, I(d) of the two variables under consideration. This is because the estimated relationship may be spurious if the variables are non-stationary (Granger, Newbold, 1974, Phillips, 1986). The conventional unit root tests (i.e. ADF, PP and KPSS) suggest that the two estimated series are integrated of order one, that is, they are I(1) processes(1). However, Perron (1989) argued that the conventional unit root tests have low power when the series are subjected to structural change and the effect of structural break(s) on the unit root test is ignored. The plots of education and health expenditures in Figure 1 clearly showed that the series are subject to structural change over the sample period from 1970 to 2007. Therefore, the conventional unit root test results may be biased. To take this into consideration, we also applied the ZA and LP unit root tests for one and two structural breaks, respectively to re-affirm the order of integration. Table 1 shows the summary of the ZA and LP unit root test results for the variables.

At the 1 per cent level of significance, the ZA test statistics cannot reject the null hypothesis of a unit root, except for health expenditure in Model C (see Table1, Panel A). This implied that the order of integration for the variables under investigation may either be I(0) or I(1) processes. In practice, the estimate series may be subject to more than one structural break, thus ZA unit root test may have low test power (Lee, Strazicich, 2003). The LP unit root test results are shown in Table 1, Panel B. Interestingly, the LP test statistics failed to reject the null hypothesis of a unit root test for both Model AA and Model CC at the 1 per cent significance level. This demonstrates that both variables of interest are integrated of order one and are thus, $I(1)$ processes[(2)]. Furthermore, this result is in line with the findings of Nelson and Plosser (1982) which showed that most of the macroeconomic variables are non-stationary at level, but are stationary after first differencing. With these findings, we then proceed to examine the short and long run causal relationship between health and education expenditures in Malaysia via the Granger and MWALD causality tests.

Table 1

The results of unit root tests with structural break(s)

Panel A: Zivot and Andrews test for unit roots with one structural break					
	Health expenditure			Education expenditure	
	Model A	Model C		Model A	Model C
TB1	1983	1986		1986	1998
$t\left(\hat{\lambda}_{\inf}\right)$	–5.242**	–5.601***		–3.701	–4.071
Lag length	3	3		1	1
Critical values:					
1 per cent	–5.34	–5.57			
5 per cent	–4.80	–5.08			
Panel B: Lumsdaine and Papell test for unit roots with two structural breaks					
	Health expenditure			Education expenditure	
	Model AA	Model CC		Model AA	Model CC
TB1 *TB2*	1986 1988	1986 1995		1978 1998	1986 1999
$t\left(\hat{\lambda}_{\inf}\right)$	–6.418**	–7.105**		–4.760	–6.227
Lag length	3	3		1	1
Critical values:					
1 per cent	–6.94	–7.34			
5 per cent	–6.24	–6.82			

Note: The asterisks *** and ** denote the significance at 1 and 5 per cent level, respectively.

A common practice in performing causality tests is to determine the optimal lag order for the autoregressive distributed lag (ARDL) model. For ease of computation, the lag structures for the causality test models can be assumed to be uniform. Nevertheless, we preferred to use the ARDL model owing to the assumption that the non-uniform lag order reflects the relationship of the variables better than the uniform lag order (Tang, 2008, Tang, Lean, 2007, 2009). The ARDL model used in this study does not include the contemporaneous variables because it is acknowledged that the present or future do not cause the past (Granger, 1969). In order to ascertain the optimal lag combination for the ARDL models, we employed the Akaike's Information Criterion (AIC). The AIC performs better than other criteria, in particular when the estimated sample size is small (Liew, 2004, Lütkepohl, 2005).

Table 2

The results of causality tests

Panel A: Short run causality – Granger test	Lag orders	Test statistics (χ^2)
$\Delta \ln HE_t \nrightarrow \Delta \ln EE_t$	1, 1	2.209
$\Delta \ln EE_t \nrightarrow \Delta \ln HE_t$	1, 1	3.662*
Diagnostic tests		Test statistics
Breusch-Godfrey serial correlation test:		
LM test [1]		0.514
LM test [2]		0.873
Heteroskedasticity test:		
ARCH LM test [1]		0.015
Ramsey RESET LR test [1]		2.208
Stability tests:		
CUSUM		Stable at 5 per cent
CUSUM of Squares		Stable at 5 per cent
Panel B: Long run causality – MWALD test	Lag Orders	Test statistics (χ^2)
$\ln HE_t \nrightarrow \ln EE_t$	3, 3	0.412
$\ln EE_t \nrightarrow \ln HE_t$	3, 2	3.806*
Diagnostic tests		Test statistics
Breusch-Godfrey serial correlation test:		
LM test [1]		0.514
LM test [2]		1.296
Heteroskedasticity test:		
ARCH LM test [1]		0.171
Ramsey RESET LR test [1]		0.000
Stability tests:		
CUSUM		Stable at 5 per cent
CUSUM of Squares		Stable at 5 per cent

Note: The asterisks ***, ** and * denote the significance at 1, 5 and 10 per cent level, respectively. The parentheses refer to the order of diagnostic tests. The AIC measure was used to determine the optimal lag combination.

The results of the causality analyses are reported in Table 2. A number of diagnostic tests are conducted on both the short and long run ARDL models to ascertain the suitability of the models. Specifically, the Breusch-Godfrey LM test statistics showed that the null hypothesis of no autocorrelation problem up to order 2 cannot be rejected. Thus the estimated ARDL models are free from serious autocorrelation problem. The Ramsey RESET test failed to reject the null hypothesis of no general specification error at the conventional significance level. We are thus confident that the estimated ARDL models for short and long run causality are correctly specified. Additionally, the ARCH LM test showed that the residuals are free from the autoregressive conditional heteroskedasticity (ARCH) problem.

For the short run causality test, the Granger causality test results revealed that the education expenditure Granger-causes health expenditure in Malaysia, but there is no evidence of the reverse causation. For the case of long run causality, the MWALD test results also indicate a unidirectional causality running from education to health expenditures in Malaysia. Interestingly, our empirical evidence appears to suggest that between the two types of human capital investments, investments on education takes precedence over that on health care in Malaysia during the period 1970 to 2007. This is consistent to the finding of Forster et al. (1981) for the case of the United Kingdom (see also Grossman, 1972). An implication of this precedence is that relatively more educated people are knowledgeable about the importance of health compared to less educated ones. They will take necessary steps to ensure that they remain healthy so as to reduce the expenditure on medical services. When confronted with the choice, investing relatively more on education rather than health services would be a more proactive and sensible planning policy. A knowledgeable society is necessary and sufficient condition for a healthier society. Thus, policy initiatives which place importance on education expenditure should be implemented. This would exert positive externalities on other parts of society, including its health aspect, thus eventually generating sustainable economic growth and development.

4. Concluding remarks

Expenditure on health and education are investments in human capital as they have an impact on labour productivity which in turn positively affects a society’s income. Although both forms of human capital investments are important, and thus expenditures are unavoidable, priority has to be set between them. This is because these expenditures usually involve huge sums and are mainly provided for by the public sector which has limited resources.

The question of interest is whether there is any causal effect between the two types of expenditure and if so, what is the direction of causality. If education unilaterally Granger-causes health, then priority should be placed on education expenditures as they eventually lead to better health and improvements in both will lead to better well-being of society.

The intention of this paper is to examine whether expenditure on health or education takes precedence in Malaysia during the period of 1970 to 2007. The empirical analysis involves the use of both the unit root and causality test procedures. Our empirical results have important implications that need to be considered by policymakers in modelling economic growth and development policies for Malaysian economy.

The unit root tests results with structural break(s) using the ZA and LP tests suggest that at the 1 per cent level of significance, both education and health expenditures in Malaysia are non-stationary, but they are stationary after first differencing. The Granger's and MWALD causality tests were applied to investigate both the short and long run causality between education and health.

The results consistently showed that education expenditure Granger-causes health expenditure, but the reverse causation does not hold. This finding conforms to most studies in various countries that showed the positive association between education and health. The general observation is that low educational attainment leads to poor health. Given the unidirectional causality from education to health expenditures, it is apparent that when policy planners are confronted by a choice between education and health expenditure, a rational policy decision would be to place more importance on education expenditure. Past education expenditure will have a positive effect on health, thus reducing health care costs to society. An educated and knowledgeable community precedes a healthy one.

Notes

(1) To conserve space, the conventional unit root tests results are not reported here, but it is available upon request from the author.

(2) In order to yield robust results for the order of integration, we also performed the ZA and LP unit root tests with the first differenced variables. The results showed that all the variables are integrated of order one. To conserve space these results are not reported here, while it is available upon request from the authors.

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