Multivariate Granger causality and the dynamic relationship between health spending, income, and health price in Malaysia

Tang, Chor Foon

Department of Economics, Faculty of Economics and Administration, University of Malaya

2010

MULTIVARIATE GRANGER CAUSALITY AND THE DYNAMIC RELATIONSHIP BETWEEN HEALTH SPENDING, INCOME, AND HEALTH PRICE IN MALAYSIA

Chor Foon TANG

Department of Economics,
Faculty of Economics and Administration, University of Malaya,
50603 Kuala Lumpur, Malaysia

ABSTRACT

This study employs the Granger causality test within a multivariate cointegration and error-correction framework to investigate the relationship between health spending, income, and health price in Malaysia. This study covers the annual sample from 1970 to 2009. The main findings of this study are that in the short-run there is uni-directional Granger causality running from health spending and health price to income in Malaysia. While, in the long-run health spending, income and health price are bi-directional Granger causality. In addition, we also extend the study to examine the dynamic interaction between the variables in the system through the forecast error variance decomposition and impulse response function analyses. In line with the finding of Granger causality, all the variables behaved endogenously in the long-run. Thus, the variables are Granger-causes each other in the long-run even there might be deviations in the short-run.

Keywords: Causality, Cointegration; Health spending; Growth; Malaysia
JEL Classification Code: C01; C22; H51; I18

1. INTRODUCTION

The role of health spending on stimulating economic growth has been advocated by Mushkin (1962). This is also known as the health-led growth hypothesis. This hypothesis claims that health is a capital, thus investment on health can be used to stimulate overall economic growth (see also Grossman, 1972). In addition, Cole and Neumayer (2006) found that poor health can reduce aggregate productivity, thus poor health appear to be a key factor in explaining the existence of underdevelopment in many regions of the world. Therefore, the question of whether or not health spending could stimulate economic growth has become a vital empirical issue. During the past decades, there have been many studies of the relationship between health spending and economic growth. However, these research efforts failed to produce clear evidence of the direction of causality. Hence, the causality relationship remains ambiguous thus far. A major problem for the disparity Granger causality findings may due to the omission of relevant variable(s) bias. Granger causality tests with bivariate framework are likely to be biased owing to the omission of relevant variable(s) that affecting the relationship between health spending and economic growth (Lütkepohl, 1982). For this reason, some studies on the relationship between health spending and economic growth attempted to include other relevant variables such as health price and aging (e.g. Hitiris and Posnett, 1992; Hansen and King, 1996).

Look at the existing literature, empirical studies on the health-growth nexus have mainly focused on the OECD and developed countries (e.g. Hansen and King, 1996; Blomqvist and Carter, 1997; Devlin and Hansen, 2001; Hartwig, 2008), thus lack of empirical study for developing countries such as Malaysia.[1] To the best of our knowledge, only three studies have attempted to examine the relationship between health spending and economic growth in Malaysia (e.g. Tang and Evan Lau, 2008; Samudram et al., 2009; Tang, 2009). Ironically, these studies may suffered from omitted of relevant variable(s) bias because they only consider the relationship between health spending and economic growth in a bivariate framework.

Pertinent to the methodological flaws, it is vital to re-investigate the time series relationship between health spending and economic growth in Malaysia. This study applies the Granger causality tests to examine the dynamic relationship between health expenditure, income, and health price in Malaysia within a multivariate Johansen's cointegration and error-correction framework.[2] In doing so, the Granger causality results are more informative and reliable than the results of bivariate framework (Lütkepohl, 1982). In addition to the analysis of Granger causality, this study also considers the forecast error variance decomposition analysis and impulse response function to examine the dynamic interrelationship between health spending, income, and health price in Malaysia. This will enhance the robustness of the results.

The remainder of this paper is organised as follows. The next section will briefly review the behaviour of health spending and economic growth in Malaysia. In Section 3, we discuss the data and econometric methods used by this study. Section 4 reports the empirical result of this study. Finally, we present the conclusions with some policy recommendations in Section 5.

2. SOME STYLISED FACTS ON ECONOMIC GROWTH AND HEALTH SPENDING IN THE MALAYSIAN ECONOMY

This section reviews the behaviour of health spending in Malaysia over the analysis period. Malaysia is a small, opened and growing economy located in the Southeast Asia region. It is well endowed with abundant of natural resources. Since the colonial days, Malaysia became the world's largest producer of tin and natural rubber. After gaining independence at 31st August 1957, the Malaysian government undertook a fundamental

[1] There are another group of literatures have focused on the cross-sectional and panel data analyses (see for example Parkin et al., 1987; Gerdtham and Löthgren, 2000, Wang and Rettenmaier, 2007; Hartwig, 2008). However, the finding may be inappropriate for policymakers to formulate effective country-specific policy. Solow (2001) claimed that an economic model should be dynamic in nature, thus an observation of the evolution of economic behaviour over time can be made. Furthermore, cross-sectional and panel data studies are based on a restrictive assumption of homogeneity in the observed relationship across countries to which homogeneity are not always the case (see Athukorala and Sen, 2002). In similar vein, Deaton (1989) added that the nature and the quality of data varied seriously across countries, therefore cross-sectional and panel data studies are likely to yield nonsensical relationship. As a result, it is more appropriate and interesting to conduct country-specific studies by examining the dynamic interaction of the variables of interest over time and thus formulate effective policy based on the findings of country-specific studies.

[2] We are aware of the fact that there are at least three common control variables that affecting health spending and economic growth. Among them are health prices, the proportion of the population under the age of 15, and the proportion of the population over the age of 65. However, we chose to include health price only because the rest of the two variables are integrated of order higher than one. Therefore, the variables have been excluded from this study.

restructuring of the economy. Nowadays, it has moved far away from the primary commodity sector and has increasingly relied on manufacturing and services sectors (Lean and Tang, 2010). Together with prudent macroeconomics policies, practical development planning and human capital investment (e.g. health and education), the economy has grown steadily. On average, the economy achieved real GDP growth rate of approximately 9.5 per cent per annum during the period of 1970 to 1980. Also, before the onset of Asian financial turmoil, the average growth rate was approximately 10.1 per cent per annum during 1980s to 1996. Nevertheless, as a result of Asian financial turmoil, the average growth rate of real GDP has dropped tremendously to 5.5 per cent per annum for the period of 1997 to 2006. Specifically, the economic growth has deteriorated to –4.5 per cent in 1998 and subsequently –3.9 per cent in 2001 due to the terrorist suicide attack the United States on 11th September 2001 (see the bar chart in Figure 1).

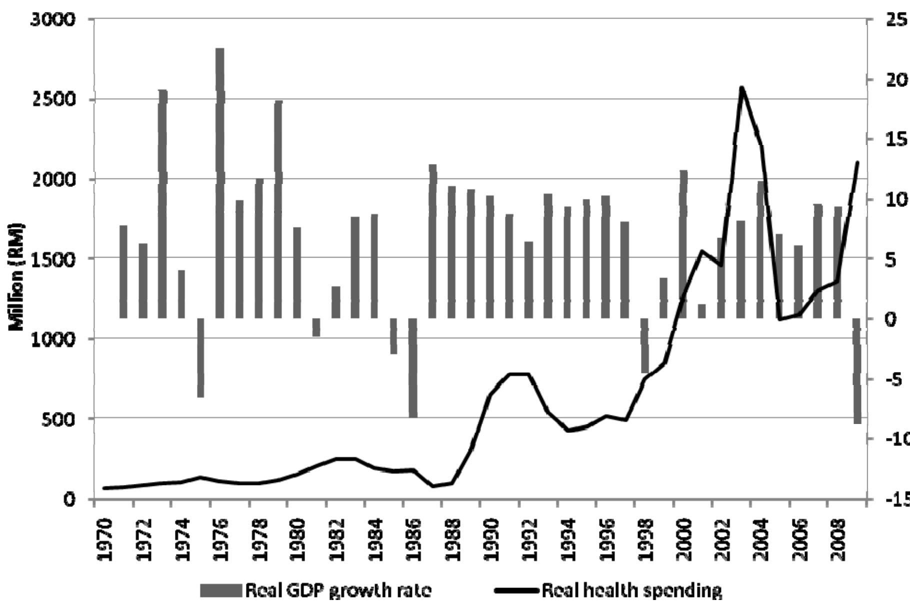

Figure 1: *The plots of real health spending and real GDP growth rate*

In view of health spending behaviour, Ramesh and Asher (2000) pointed out that Southeast Asia nations have experienced significant improvements in their health care system in the past decades. As far as Malaysia is concerned, Ramesh and Wu (2008) stated that Malaysia has been one of the countries with largest improvement in the health care sector among the ASEAN countries. Malaysia's health care is a mix of private-public system which operates in parallel with heavy involvement of the public sector in the provision of health services. Moreover, WHO (2000) documented in the World Health Report 2000 that Malaysia was ranked at 49 among 191 members of the World Health Organisation.

The plots of real health spending and real GDP growth rate in Malaysia are depicted in Figure 1. It is evidence that health spending could be a prominent source for sustainable economic growth in Malaysia as these variables are closely correlated over the analysed period of 1970 to 2009. Over the period 40 years, health spending in Malaysia show an increasing trend coupled with some evidences of instability such as 1984-1987, 1994-1997, and 2003-2004. These instabilities may results from the world economic downturn in 1980s, a combination of the Asian financial crisis and the outbreak of Coxackie B and Japanese Encephalitis in 1997/98, and the Severe Acute Respiratory Syndrome (SARS) and Avian flu in 2003.

In early of 1980, the ASEAN's Health Ministers coherently emphasised on promoting health care system such as exchange of information on health, as well as expertise in health development. In addition to that, the Ministry of Health department also implemented some corporative research works and promote health manpower development to improve the quality of life. For this reason, Malaysian government increased the health spending from 155 million in 1980 to 252 in 1983 before the onset of the world economic recession in the middle of 1980s. However, health spending further increased after 1988 to its peak at 780 million in 1992. This reflected the urge of the Malaysian government to promote health care system. Due to the Asian financial crisis, the health spending in Malaysia decreased to 493 million in 1997. Furthermore, as a result of fears arising from SARS and avian flu, the health spending in Malaysia increased from 1548 million in 2001 to 2571 million in 2003 to prevent and control the spread of these diseases. After this, the outbreak of influenza A (H1N1) caused the health spending in Malaysia grows again to its peak at 2108 million in 2009. Moreover, Anonymous (2009) added that the increase of health spending in Malaysia for the period of 2003 to 2009 may also due to the privatisation and upgrading of existing health care infrastructure within the public health system.

3. UNIT ROOTS, COINTEGRATION, AND GRANGER CAUSALITY

3.1 Data and unit root tests

This study employs the government spending on health as a proxy for health spending in Malaysia. This is because health care spending is unavailable for Malaysia. Moreover, the gross domestic product (GDP) is a proxy for income or economic growth, and consumer price index for health (P) is a proxy for health price in Malaysia. The time frame of this study is covers from 1970 to 2009. The data of this study is extracted from *International Financial Statistics* (IFS), Bank Negara Malaysia, *Monthly Statistical Bulletin*, and the Malaysian Economic Report, respectively. Annual data are used in this study because there is no other frequency of data for such a long span. The consumer price index (CPI, 2000 = 100) is used to derive the real term.

According to Granger and Newbold (1974) and Phillips (1986), regression results may be spurious if the variables are non-stationary. To avoid spurious estimation results, it is essential to determine the order of integration for each series. To affirm the order of integration for each series, we applied the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests. The results of ADF and PP unit root tests are presented in Table 1.

According to the unit root test results, the ADF test statistics cannot reject the null hypothesis of a unit root at levels for all the variables, except for health spending. While, PP unit root test cannot reject the null hypothesis of a unit root at level for all the variables included health spending. When one takes the first difference of each of the variables, both ADF and PP unit root tests consistently reject the null hypothesis of a unit root. As a result, the ADF test suggests that income and prices are integrated of order one process, but health spending is integrated of order zero (i.e. stationary at level). On the contrary, PP test demonstrate that all variables included health spending in Malaysia are non-stationary at level, but they are stationary after first differencing. In this spirit, the PP test suggest that all the variables are integrated of order one, $I(1)$ process. Hallam and Zaloni (1993) and Obben (1998) noted that if the ADF and PP results are inconsistent, the results of PP test is preferred because it more powerful than the ADF test in particular when the estimates sample is small.

Table 1: The results of unit root tests

Variables	ADF	PP
$\ln HE_t$	–4.729 (3)***	–2.964 (3)
$\Delta \ln HE_t$	–4.735 (3)***	–4.080 (5)**
$\ln Y_t$	–2.684 (0)	–2.684 (0)
$\Delta \ln Y_t$	–5.288 (1)***	–5.305 (3)***
$\ln P_t$	–2.299 (2)	–0.743 (2)
$\Delta \ln P_t$	–3.226 (3)*	–4.950 (2)***

Note: The asterisks *** and ** represent the significance level at 1 and 5 per cent. ADF and PP refer to Augmented Dickey-Fuller and Phillips-Perron unit root tests. The optimal lag length for ADF test is selected using the AIC while the bandwidth for PP tests are selected using the Newey-West Bartlett kernel. Figure in parentheses ( ) denotes the optimal lag length and bandwidth. The critical values for ADF and PP tests are obtained from MacKinnon (1996).

Therefore, we surmise that the estimated variables are integrated of order one $I(1)$ process. [3] These results are consistent to the assertion that most of the macroeconomics time series are non-stationary at level, but it is stationary after first differencing (see Nelson and Plosser, 1982). With these findings, we proceed to examine the presence of long-run equilibrium relationship through the multivariate Johansen-Juselius cointegration test.

3.2 Cointegration test

In this section, we test the presence of long-run equilibrium relationship between health spending and its determinants with the multivariate Johansen-Juselius cointegration approach (see Johansen, 1988; Johansen and Juselius, 1990). The major advantage of using multivariate cointegration for the present purpose is that it has superior properties in particular for two and more variables system. Unlike the two-step residuals-based test for cointegration developed by Engle and Granger (1987) and the bounds testing procedure for cointegration suggested by Pesaran et al. (2001), the multivariate Johansen-Juselius cointegration approach is not sensitive to the choice of dependent variables because it assumed that all variables are endogenous. The Johansen-Juselius cointegration approach can be applied within the vector error-correction model (VECM) as follow:

$$\Delta W_t = \Phi D_t + \Pi W_{t-1} + \Gamma_1 \Delta W_{t-1} + \cdots + \Gamma_{k-1} \Delta W_{t-k+1} + \mu_t \qquad (1)$$

where Δ is the first difference operator $\left(w_t - w_{t-1}\right)$, W_t is $\left(n \times 1\right)$ of endogenous variables $\left[\ln HE_t, \ln Y_t, \ln P_t\right]'$ and each of the A_i is an $\left(n \times n\right)$ matrix of parameters. The deterministic term D_t contains constants, a linear terms or seasonal dummies. $\Gamma = -\left(I - A_1 - \cdots - A_i\right)$,

[3] However, there might be structural breaks for the variables under investigation. According to Perron (1989) and Zivot and Andrews (1992), the standard unit root tests may be low power when the variables confronted with break(s). For this reason, we also conducted the *m*-breaks Kapetanois (2005) unit root test to re-confirm the order of integration for each variable. Evidently, the results of *m*-breaks unit root test up to three structural breaks (i.e. m =1, m = 2, and m = 3) show no additional evidence compare to the standard unit root tests. Hence, we surmise that all the variables are non-stationary at level. To conserve space the results are not reported here, but it is available upon request from the author.

$(i = 1, \ldots, k-1)$, and $\Pi = -(I - A_1 - \cdots - A_k)$. This way of specifying the system contains information on both short and long run adjustments to changes in W_t, through the estimates of $\hat{\Gamma}$ and $\hat{\Pi}$, respectively. k is the lag structure and the error terms μ_t are assumed to be normally distributed and white noise. In Johansen-Juselius approach, $\Pi = \alpha\beta'$ is $(n \times n)$ coefficient matrix called the impact matrix and contains information about the long-run equilibrium relationship between the said variables. α is the parameter denoting the speed of adjustment to disequilibrium, while β is a matrix of cointegrating vectors.

Johansen-Juselius cointegration approach offered two likelihood ratio (LR) test statistics, namely trace test, $LR(\lambda_{\text{trace}}) = -T\sum_{i=r+1}^{k} \ln(1-\hat{\lambda}_i)$ and maximum eigenvalues test, $LR(\lambda_{\max}) = -T\ln(1-\hat{\lambda}_{i+1})$, where T represents the total numbers of observations and $\hat{\lambda}_i$ are the eigenvalues $(\lambda_1 \geq \lambda_2 \ldots \geq \lambda_k)$. Furthermore, we noted that Johansen-Juselius cointegration test prone to reject the null hypothesis of no cointegrating relation when the estimated sample size is small (see Reimers, 1992; Cheung and Lai, 1993). For this reason, we employed the surface responses procedure developed by Cheung and Lai (1993) to correct the critical values avoid the small sample bias problem.

Table 2: The result of Multivariate Johansen cointegration test

Hypothesis		LR tests statistics	Adjusted critical values#	
H_0	H_A		5 per cent	10 per cent
$LR(\lambda_{\text{trace}})$				
$r = 0$	$r \geq 1$	55.604**	40.4203	37.0237
$r \leq 1$	$r \geq 2$	30.767**	23.1106	20.6523
$r \leq 2$	$r \geq 3$	7.046	10.6985	8.7006
$LR(\lambda_{\max})$				
$r = 0$	$r = 1$	24.837*	25.5691	22.9251
$r \leq 1$	$r = 2$	23.721**	18.2122	15.9444
$r \leq 2$	$r = 3$	7.046	10.7390	8.7201

Note: ** and * denote statistical significance at the 5 and 10 per cent level, respectively. # represent that the critical values were adjusted by the Cheung and Lai (1993) surface response procedure. The system-wise Akaike's Information Criterion (AIC) was used to select the optimal lag order.

The common practice for the multivariate Johansen-Juselius cointegration test is to determine the lag structure for the VECM system. In this respect, Hall (1991) pointed out that the choice of lag structure in the VECM system is vital because too few lags may lead to serial correlation problem, whereas too many lags specified in the VECM system will consume more degree of freedoms thus lead to small sample problem. For this reason, the optimal VECM system for multivariate Johansen-Juselius cointegration test was determined by minimising the system-wise Akaike's Information Criterion (AIC). The AIC was used because Liew (2004) and Lütkepohl (2005) found that AIC performed better than any other information criterions (e.g. SBC and HQ) when the estimated sample size is relatively small (e.g. less that 60 observations). The AIC statistic indicates that 2 years lag is the optimal lag length for the multivariate Johansen-Juselius cointegration test. Table 2 presents the results for both multivariate Johansen-Juselius likelihood ratio (LR) cointegration test – $LR(\lambda_{\text{trace}})$ and $LR(\lambda_{\max})$. At the 10 per cent significance level, both LR statistics consistently reject null hypothesis of more than one cointegrating vectors $((r \leq 1)$, but cannot reject the null hypothesis of more than two cointegrating vectors $(r \leq 2)$. As a result, the variables are cointegrated and there are two cointegrating vectors among the three variables system.

3.3 Granger causality test

Once the variables are found to be cointegrated, then there must be Granger cause in at least one direction to hold the existence of long-run equilibrium relationship (Granger, 1986). For this reason, we estimate the following multivariate *k*th order of vector error-correction model (VECM) for testing Granger causality:

$$\Delta \ln HE_t = \alpha_1 + \sum_{i=1}^{k} \delta_i \Delta \ln HE_{t-i} + \sum_{i=0}^{k} \phi_i \Delta \ln Y_{t-i} + \sum_{i=0}^{k} \varphi_i \Delta \ln P_{t-i} + \psi_1 ECT_{t-1} + \mu_{1t} \tag{2}$$

$$\Delta \ln Y_t = \alpha_2 + \sum_{i=1}^{k} \phi_i \Delta \ln Y_{t-i} + \sum_{i=0}^{k} \delta_i \Delta \ln HE_{t-i} + \sum_{i=0}^{k} \varphi_i \Delta \ln P_{t-i} + \psi_2 ECT_{t-1} + \mu_{2t} \tag{3}$$

$$\Delta \ln P_t = \alpha_1 + \sum_{i=1}^{k} \varphi_i \Delta \ln P_{t-i} + \sum_{i=0}^{k} \delta_i \Delta \ln HE_{t-i} + \sum_{i=0}^{k} \phi_i \Delta \ln Y_{t-i} + \psi_3 ECT_{t-1} + \mu_{3t} \tag{4}$$

Here Δ is the first difference operator and the residuals μ_{it} are assumed to be spherically distributed and white noise. In addition to the variables defined above, ECT_{t-1} is the one period lagged error-correction term derived from the cointegrating equation (this term will be excluded if the variables are not cointegrated). There are two sources of causation, i.e. short-run causality and long-run causality. The t-significance of the one period lagged error-correction term, ECT_{t-1} is normally used to determine the long-run causality and the speed of convergence to the long-run equilibrium if the system expose to shock. On the other hand, to examine the short-run causality, we used the likelihood ratio (LR) statistics. From equation 2, $\phi_i = 0 \forall_i$ implies that income does not Granger-cause health spending; while from equation (3), $\delta_i = 0 \forall_i$ implies that health spending does not Granger-cause income. Similarly, the null hypothesis $\varphi_i = 0 \forall_i$ can be interpreted in the same way with regard to causal effect of health prices on health spending and income in Malaysia.

The Granger causality test results are reported in Table 3. We begin our analysis with the short-run causality results. We find that there is uni-directional Granger causality running from health spending and prices to income in the short-run at the 5 per cent and 10 per cent significance levels, respectively. This result supports the health-led growth hypothesis in Malaysia. In the long-run, the coefficient of the one period lagged error-correction term, ECT_{t-1} is in negative sign and statistically significant at the 1 per cent level in all equations.

This implies that health spending, income, and health price in Malaysia are bi-directional Granger causality in the long-run. As a summary, the Granger causality results of Malaysia dataset are consistent to Mushkin (1962) assertion that health is a capital and thus investment on health is a prominent source to generate economic growth in either short-run or long-run.

Table 3: The results of Granger causality

Dependent variable	Likelihood Ratio (LR) statistics $\Delta \ln HE_t$	$\Delta \ln Y_t$	$\Delta \ln P_t$	ECT_{t-1} [t-statistics]
$\Delta \ln HE_t$	–	0.111	0.091	–0.830 [–4.938]***
$\Delta \ln Y_t$	7.823**	–	2.906*	–0.614 [–3.197]***
$\Delta \ln P_t$	2.758	0.814	–	–0.126 [–2.766]***

Note: The asterisks ***, ** and * denote statistical significance at the 1, 5 and 10 per cent levels, respectively.

4. FORECAST ERROR VARIANCE DECOMPOSITIONS AND IMPULSE RESPONSE FUNCTIONS ANALYSES

To this end, the Granger causality analysis has been constrained to in-sample test and has not considered the dynamic interaction of the variables beyond the sample period. In this spirit, we consider the forecast error variance decomposition analysis (Sims, 1980). The forecast error variance decomposition analysis provides information about the relative strength of random shock in the system. Therefore, if a variable is truly exogenous, the forecast error variance will be explained by its own shock only (Sims, 1980). Table 4 summarised the results of the variance decomposition up to 15 years.

The variance decompositions analysis is computed by disturbing each variable in the system with one-standard deviation. There are several interesting findings emerge from the variance decomposition results. In the short-run, health price is the most exogenous variables, follow by income and health spending. After two years, 99.2 per cent, 92.7 per cent and 90.3 per cent of the variation in the forecast error variance for health price, income, and health spending is explained by its own shock, respectively. However, in the long-run all the variables tend to be endogenous, implying that the variables are Granger-cause each other in the long-run. In explaining the shocks to health spending, income is more important than health care price in both the short-run and long-run. In addition, income also more important than health spending in explaining shocks to health price in the long-run (after three years), but in the short-run health spending is more important than income. In explaining the shocks to income (economic growth), health spending is relatively more important than health care price in both the short-run and long-run. After two years, 5.5 per cent of the variation in income being explained by health spending, while health prices only explained 1.7 per cent of the variation in income. Then, the statistics for health spending and health prices increases to 29.8 per cent and 10.1 per cent, respectively after fifteen years. Therefore, health spending play more important role than health care price in generating income growth in Malaysia. This is consistent with the finding of Granger causality results presented in Table 3.

Thus far, we have examined the causal effect with the Granger causality test and the forecast error variance decomposition analysis reported in Table 3 and Table 4, respectively. The previous tests only provide the direction of causality, but they are unable to explain the sign (i.e. positive or negative) of the causal relationship and how long these effects require to take place in the system. Hence, we perform the impulse response function to trace out the response to a shock to each of the variables in the system. The results of impulse response function of health spending, income and health price to a one-standard deviation shocks in health spending, income and health price over a 15 years period are illustrated in Figure 2 to Figure 4.

Table 4: The results of variance decompositions analysis

Relative variance of health			
Years	Health	Income	Health price
1	100.00	0.00	0.00
2	90.28	9.58	0.14
3	71.82	27.24	0.94
4	60.40	37.07	2.53
5	55.11	40.65	4.24
10	48.19	43.19	8.61
15	43.46	45.28	11.26
Relative variance of income			
1	0.63	99.37	0.00
2	5.54	92.73	1.72
3	9.69	87.82	2.50
4	12.20	84.65	3.15
5	16.25	80.09	3.66
10	26.11	66.72	7.17
15	29.79	60.10	10.11
Relative variance of health price			
1	0.29	0.01	99.70
2	0.75	0.01	99.24
3	1.87	0.44	97.69
4	1.45	5.53	93.02
5	1.34	13.57	85.09
10	4.20	47.56	48.24
15	16.59	62.24	21.17

Note: Cholesky ordering: health, income and health price

Beginning with Figure 2, the results of impulse response function demonstrate that over the fifteen years period, a shock in income exert a positive impact on health spending. A shock in income leads to a rise in health spending for the first three years, while between year three and five there is a sharp decline in the health spending, but fluctuate around the positive level and stabilises thereafter. However, a shock to health price decrease health spending in the first four years, thereafter fluctuate around the negative level before it stabilise after year seven. This implied that a shock to health price exerts a negative impact on health spending in Malaysia. Turning to Figure 3, a shock to health spending has a positive impact on income while a shock in health price has a negative impact on income over the fifteen years. From

Figure 4, it can be seen that a shock to income increase health price in the first twelve years and stabilise thereafter. On the other hand, a shock to health spending increases health price in the first three years, while there is a wide fluctuation between year three and twelve, and stabilise thereafter.

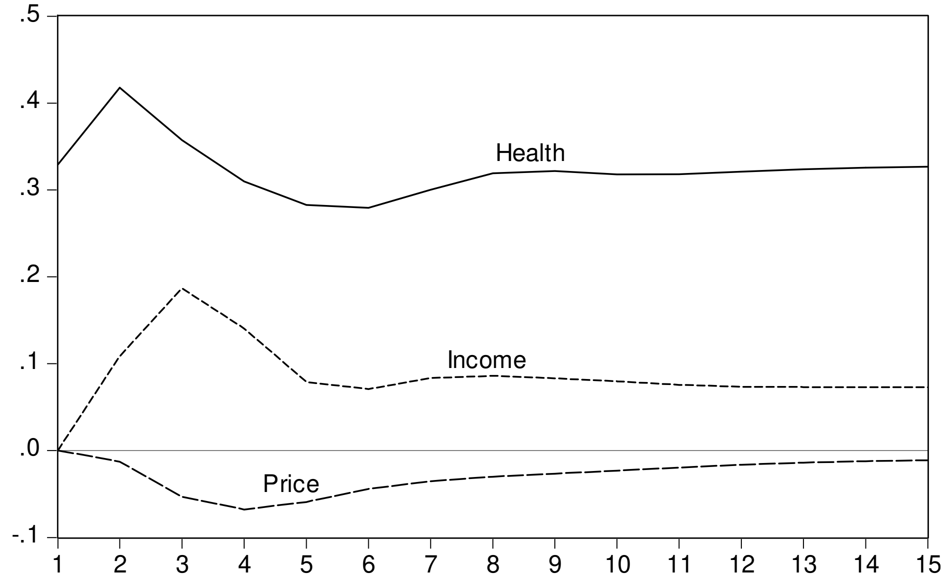

Figure 2: *Impulse responses of health to a one-standard deviation shock in health, income, and health price*

Figure 3: *Impulse responses of income to a one-standard deviation shock in income, health, and health price*

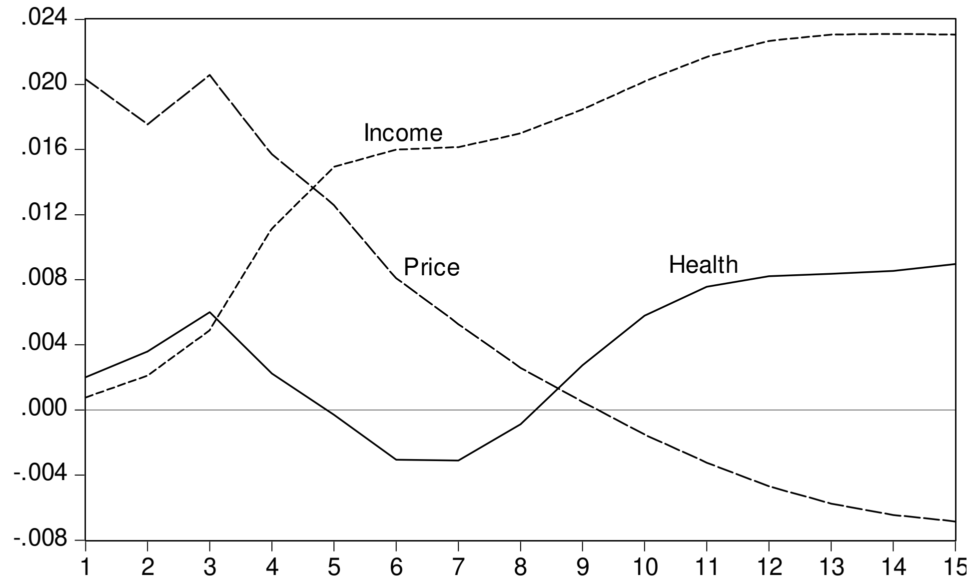

Figure 4: *Impulse responses of health price to a one-standard deviation shock in health price, income, and health*

4. CONCLUSION AND POLICY RECOMMENDATIONS

Given that healthy society are more productive and efficient in generating economic growth and development, the interaction between health spending, income, and health price is of paramount important for the Malaysian economy. This study is the first attempts to examine the Granger causality between health spending, income, and health price in Malaysia within a multivariate cointegrated system. This study covers the updated annual sample period from 1970 to 2009. The Johansen-Juselius cointegration test suggests that the variables are cointegrated, implying that there is a unique long-run equilibrium relationship between health spending, income, and health price in Malaysia. With the finding of cointegration, we investigated the direction of causality between the variables through the VECM framework. The main findings of this study are that in the short-run there is uni-directional Granger causality running from health spending and health price to income growth in Malaysia. While, in the long-run health spending, income and health prices are bi-directional Granger causality.

Beyond this, we also undertook the forecast error variance decomposition and the impulse response function analyses to examine the dynamic interaction between health spending, income and health price in Malaysia. In doing so, we provide policymakers with additional insight on the relative importance of random shocks and the response of variables to the shocks. In the long-run, all three variables are endogenous, thus they are causally related. Income is the most important variable in explaining shocks to health spending, while health spending is the most important variable in explaining shocks to income. In similar vein, the impulse response function show that shocks to health spending has a positive impact on income growth; moreover shock to income also has a positive effect on health spending in Malaysia. These results implied that there is a strong positive bi-directional Granger causality between health spending and economic growth.

In view of policy recommendations, the findings of this study suggest that health spending played an important role in promoting economic development in Malaysia.

Therefore, policies to encourage health spending are required to build up a healthier and productive society to support Malaysia's economic growth and development. This is because healthier individual may be more productive than those who are ill, thus enabling them to generate more output. In addition to that, the Ministry of Health should aggressively minimise the gap of inequality distribution of health care among people in Malaysia by providing the basic health care to the poor society, particularly in the rural area. Furthermore, the Ministry of Health and also the Ministry of Education have to cooperate in promoting the important of health care and providing health care information to the Malaysian society. Moreover, external cooperation such as World Health Organisation is also required to exchange of expertise and health care information. In line with the Ninth Malaysian Plan (2006 to 2010), health spending is vital either for individual or country because without healthier society, it will be difficult to create a society with high capacity of knowledge and innovation and nurture first class mentality.

REFERENCES

Anonymous (2009) Healthcare expenditure in Malaysia increasing, *Bernama*, August, August 5th 2009.

Asian Development Bank (2006) *Key Indicators 2006: Measuring Policy Effectiveness in Health and Education*. Asian Development Bank

Athukorala, P. and Sen, K. (2002) *Saving, Investment, and Growth in India*. Oxford University Press, Oxford.

Blomqvist, A.G. and Carter, R.A.L. (1997) Is health care really a luxury? *Journal of Health Economics*, 16(2), pp. 207-229.

Cheung, Y.W. and Lai, K.S. (1993) Finite-sample sizes of Johansen's likelihood ratio tests for cointegration. *Oxford Bulletin of Economics and Statistics*, 55(3), pp. 313-328.

Cole, M.A. and Neumayer, E. (2006) The impact of poor health on total factor productivity. *Journal of Development Studies*, 42(6), pp. 918-938.

Deaton, A.S. (1989) Saving in developing countries: Theory and review. In: *Proceedings of the World Bank Annual Conference on Development Economics 1989* (Eds) S. Fischer and D. de Tray, World Bank, Washington, D.C., pp. 61-108.

Devlin, N. and Hansen, P. (2001) Health care spending and economic output: Granger causality. *Applied Economics Letters*, 8(8), pp. 561-564.

Engle, R.F. and Granger, C.W.J. (1987) Co-integration and Error Correction: Representation, Estimation and Testing. *Econometrica*, 55(2), pp. 251-276.

Gerdtham, U. and Löthgren, M. (2000) On stationary and cointegration of international health expenditure and GDP. *Journal of Health Economics*, 19(4), pp. 461-475.

Granger, C.W.J. (1986) Development in the study of co-integrated economic variables. *Oxford Bulletin of Economics and Statistics*, 48(3), pp. 213-228.

Granger, C.W.J. and Newbold, P. (1974) Spurious regression in econometrics. *Journal of Econometrics*, 2(2), pp. 111-120.

Grossman, M. (1972) On the concept of health capital and the demand for health. *Journal of Political Economy*, 80(2), pp. 223-255.

Hall, S.G. (1991) The effect of varying length VAR models on the maximum likelihood estimates of cointegrating vectors. *Scottish Journal of Political Economy*, 38(4), pp. 317-323.

Hallam, D. and Zanoli, R. (1993) Error correction models and agricultural supply response. *European Review of Agricultural Economics*, 20, pp. 151-166.

Hansen, P. and King, A. (1996) The determinants of health care expenditure: A cointegration approach. *Journal of Health Economics*, 15(1), pp. 127-137.

Hartwig, J. (2008) What drives health care expenditure? – Baumol's model of 'unbalanced growth' revisited. *Journal of Health Economics*, 27(3), pp. 603-623.

Hitiris, T. and Posnett, J. (1992) The determinants and effects of health expenditure in developed countries. *Journal of Health Economics*, 11(2), pp. 173-181.

Johansen, S. (1988) Statistical analysis of cointegrating vector. *Journal of Economic Dynamics and Control*, 12(2-3), pp. 231-255.

Johansen, S. and Juselius, K. (1990) Maximum likelihood estimation and inference on cointegration with applications to the demand for money. *Oxford Bulletin of Economics and Statistics*, 52(2), pp. 169-210.

Kapetanios, G. (2005) Unit-root testing against the alternative hypothesis of up to *m* structural breaks. *Journal of Time Series Analysis*, 26(1), pp. 123-133.

Lean, H.H. and Tang, C.F. (2010) Is the tourism-led growth hypothesis stable for Malaysia? A note. *International Journal of Tourism Research*, 12(4), pp. 375-378.

Liew, K.S. (2004) Which lag length selection criteria should we employed? *Economics Bulletin*, 3, pp. 1-9.

Lütkepohl, H. (1982) Non-causality due to omitted variables. *Journal of Econometrics*, 19, pp. 367-378.

Lütkepohl, H. (2005) *New Introduction to Multiple Time Series Analysis*. Springer-Verlag, Germany.

MacKinnon, J.G. (1996) Numerical distribution functions for unit root and cointegration tests. *Journal of Applied Econometrics*, 11(6), pp. 601-618.

Mushkin, S.J. (1962) Health as an investment. *Journal of Political Economy*, 70(5), pp. 129-157.

Nelson, C.R. and Plosser, C.I. (1982) Trends and random walks in macroeconomic time series: Some evidence and implications. *Journal of Monetary Economics*, 10(2), pp. 139-162.

Obben, J. (1998) The demand for money in Brunei. *Asian Economic Journal*, 12(2), pp. 109-121.

Parkin, D., McGuire, A. and Yule, B. (1987) Aggregate health care expenditures and national income: Is health care a luxury goods? *Journal of Health Economics*, 6(2), pp. 109-127.

Perron, P. (1989) The great crash the oil price shock and the unit root hypothesis. *Econometrica*, 57, pp. 1361-1401.

Pesaran, M.H., Shin, Y. and Smith, R.J. (2001) Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, 16(3), pp. 289-326.

Phillips, P.C.B. (1986) Understanding spurious regression in econometrics. *Journal of Econometrics*, 33(3), pp. 311-340.

Ramesh, M. and Asher, M. (2000) *Welfare Capitalism in Southeast Asia: Social Security, Health, and Education Policies in Indonesia, Malaysia, the Philippines, Singapore and Thailand*. Basingstoke: Macmillan.

Ramesh, M. and Wu, X. (2008) Realigning public and private health care in Southeast Asia. *The Pacific Review*, 21(2), pp. 171-187.

Reimers, H.E. (1992) Comparison of tests for multivariate cointegration. *Statistical Papers*, 33(1), pp. 335-359.

Samudram, M., Nair, M. and Vaithilingam, S. (2009) Keynes and Wagner on government expenditures and economic development: The case of a developing economy. *Empirical Economics*, 36(3), pp. 697-712.

Sims, C. (1980) Macroeconomics and reality. *Econometrica*, 48, pp. 1-48.

Solow, R. (2001) Applying growth theory across countries. *World Bank Economic Review*, 15(2), pp. 283-288.

Tang, C.F. (2008) Wagner's law versus Keynesian hypothesis: New evidence from recursive regression-based causality approaches. *ICFAI Journal of Public Finance*, 6(4), pp. 29-38.

Tang, C.F. (2009) An examination of the government spending and economic growth nexus for Malaysia using the leveraged bootstrap simulation approach. *Global Economic Review*, 38(2), pp. 215-227.

Tang, C.F. and Evan Lau, P.H. (2008) Wagner versus Keynes hypotheses: Disaggregated public expenditure and income for Malaysia. In: *Proceedings of the 3rd International Borneo Business Conference 2008*, Kota Kinabalu, Sabah, Universiti Malaysia Sabah, pp. 286-296.

Wang, Z.J. and Rettenmaier, A.J. (2007) A note on cointegration of health expenditures and income. *Health Economics*, 16(6), pp. 559-578.

WHO (2000) *World Health Report 2000*: *Health systems improving performance*, World Health Organisation.

Zivot, A. and Andrew, D.W.K. (1992) Further evidence on the great crash the oil shock and the unit root hypothesis. *Journal of Business and Economic Statistics*, 10, pp. 251-270.