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MULTIVARIATE GRANGER CAUSALITY AND THE DYNAMIC RELATIONSHIP BETWEEN HEALTH CARE SPENDING, INCOME AND RELATIVE PRICE OF HEALTH CARE IN MALAYSIA*

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Abstract

This study employs the Granger causality test within a multivariate cointegration and error-correction framework to investigate the relationship between health care spending, income and relative 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 relative price to health care spending, while relative price and income are bi-directional Granger causality in Malaysia. In the long-run health care spending and income are bi-directional Granger causality, while there is uni-directional Granger causality running from relative price to health care spending and income. 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 though there might be deviations in the short-run.

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

I. *Introduction*

The role of health care 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 in turn lead to overall economic growth (see also Grossman, 1972). As emphasised by Cole and Neumayer (2006), poor health has an adverse impact on productivity, thus it appears to be a key factor in explaining the

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existence of underdevelopment in many regions throughout the world. Therefore, the question of whether or not health care spending can stimulate economic growth has become a vital empirical issue. In fact, health can affect economic growth through its impact on human and physical capital accumulation (Bloom and Canning, 2000; Jack and Lewis, 2009), given that healthier people are more productive compare to those who are ills. Moreover, people who are healthy have a strong incentive to develop their knowledge and skills because they expect to enjoy the benefit over longer period (Bloom and Canning, 2000). Hence, change of health-state of the population may influence economic growth through its impact on human capital accumulation. Apart from that, healthy population may accumulate physical capital such as savings more quickly because better population health will lower infant and child mortality which cause an increase in the size of working age population.[1] As this happen, higher savings lead to higher investment, which in turn leads to higher economic growth (Solow, 1956; Romer, 1986). In this way, health plays an important role in the process of economic growth through its impact on physical capital accumulation.

On the other hand, economic growth can also improve the health-state of population through purchase of medical care (input for health capital), but this relationship is in concave form because health is deemed as a capital thus subject to the assumption of diminishing marginal return (Grossman, 1972). From the microeconomic view point, when individual's income is low (poor), his/her demand for medical care tend to be low. As a result, the marginal rate of return for his/her to invest in health via medical care is high because low income individual tends to be in the unhealthy state compared to the rich, thus a small increase of income will indirectly improve his/her health state due to increase of demand for medical care. However, once individual reaches a very healthy and wealthy state, an additional income will not make this individual healthier, but stagnant. As a matter of fact, this concave relationship is further supported by Preston (1975) study with macroeconomic dataset. He found that among the poor countries, increase in per capita income are strongly associated with increases in health state proxied by life expectancy, but this relationship is weak or even disappear when the countries approached a very high level of per capita income. Therefore, people in poor countries are usually less healthy compared to their rich counterparts, and the relationship between health and economic growth varies depending on the level of development.

During the past decades, there have been many studies of the relationship between health care 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. Studies which conduct Granger causality test with a bivariate framework are likely to be biased owing to the omission of relevant variable(s) that affecting the relationship between health care spending and economic growth (Lütkepohl, 1982). For this reason, studies on the relationship between health care spending and economic growth

[1] Bloom and Canning (2000) named this phenomenon as demographic dividend. According to them, one-third of the impressive growth performance of the East Asia economies was attributed to the demographic dividend. Over two decades, the working age population grew several times faster than the dependent population (i.e. young and old). This is mainly due to the declined in infant and child mortality. Therefore, demographic change is important to transmit the effect of health improvement to economic growth. Regrettably, improvement of health status will reduce per capita income because the low mortality rate will increase the aggregate population growth, thereby lowering the capita-to-labour ratio and reducing labour productivity in per capita term.

attempted to include other relevant variables such as health care price and aging (e.g. Hitiris and Posnett, 1992; Hansen and King, 1996).

Looking 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; Tokita et al., 2000; Devlin and Hansen, 2001; Chang and Ying, 2006; Hartwig, 2008), thus lack of empirical study for developing countries such as Malaysia.[2] 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. Rao et al., 2008; Samudram et al., 2009; Tang, 2009) have been discovered. Ironically, these studies may suffered from omitted of relevant variable(s) bias because they only consider the relationship between health care 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 care spending and economic growth in Malaysia. This study applies the Granger causality tests to examine the dynamic relationship between health care spending, income and relative price in Malaysia within a multivariate Johansen's cointegration and error-correction framework.[3] 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 care spending, income and relative price of health care 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 III, we discuss the data and econometric methods used by this study. Section IV reports the empirical results of this study. Finally, we present the conclusions with some policy recommendations and the limitations of this study in Section V.

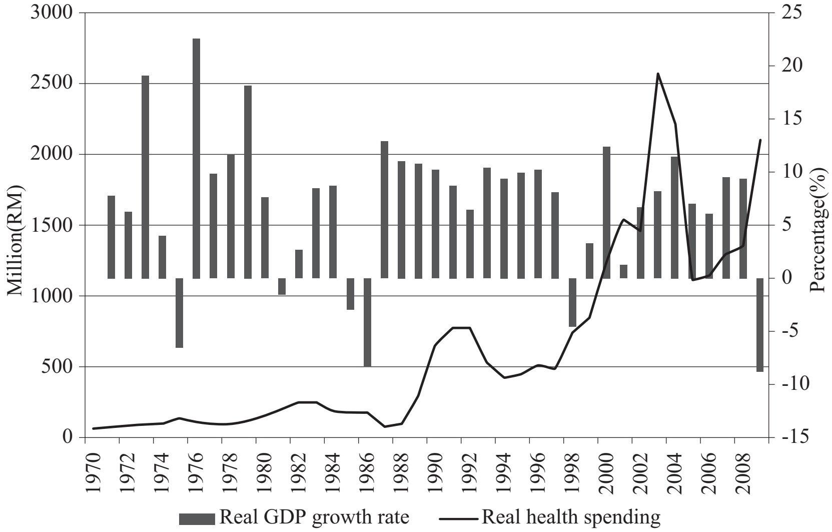
II. *Some Stylised Facts on Economic Growth and Health Care Spending in Malaysia*

This section reviews the behaviour of health care spending in Malaysia over the last four decades. Malaysia is a small open 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 on 31st August

[2] There is another group of literature that 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, their findings 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. 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.

[3] We are aware of the fact that other control variables that affecting health spending and economic growth. Among them are the proportion of the population under the age of 15, and the proportion of the population over the age of 65. However, these variables were dropped from the system because they were integrated of an order higher than one.

FIG. 1. THE PLOTS OF REAL HEALTH SPENDING AND REAL GDP GROWTH RATE



1957, the Malaysian government undertook a fundamental restructuring of the economy. Nowadays, it has moved 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 real GDP growth rate has deteriorated to −4.5 per cent in 1998 and subsequently grew at 1.3 per cent only in 2001 due to the terrorist suicide attack on the United States on 11th September 2001 (see the bar chart in Figure 1).

In view of health care 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 the 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 care 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 care spending and real GDP growth rate in Malaysia are depicted in Figure 1. Over the period 40 years, health care spending in Malaysia show an increasing trend coupled with some evidences of instability in 1984-1987, 1994-1997 and 2003-2004. These instabilities were the results of 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 care 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 care 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 care spending in Malaysia decreased to 493 million in 1997. Furthermore, as a result of fears arising from SARS and avian flu, the health care 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 care spending in Malaysia to grow again to its peak at 2108 million in 2009. Moreover, Bernama (2009) added that the increase of health care 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.

III. *Unit Roots, Cointegration and Granger Causality*

1. Data and Unit Root Tests

This study employs the real per capita government spending on health as a proxy for health care spending in Malaysia (HE) because the private health care spending is unavailable. Moreover, the real per capita gross domestic product (GDP) is a proxy for income and economic growth. Follows the past literatures, the ratio of the price index for health to the GDP deflator can be used as a proxy for relative price of health care (e.g. Milne and Molana, 1991; Gerdtham et al., 1992; Hansen and King, 1996; Roberts, 1999; Okunade and Karakus, 2001).[4] The time frame of this study 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 this is the only data frequency available between 1970 to 2009. The consumer price index (CPI, 2000=100) is used to derive the real term.

[4] Unlike the earlier studies on Malaysia (e.g. Rao et al., 2008; Samudram et al., 2009; Tang, 2009), we use the real per capita health care spending and real per capita GDP. Moreover, this study employs the relative price of health care rather than health care price because consumer purchase decision of medical care not only depend on its own price but also rely on the price of other goods and services. Moreover, the relative price of health care also poses as a choice faced by policymakers to fully utilise the available resources. Hence, the relative price of health care is more reasonable and better reflects the effect of price on health care. According to Department of Statistics Malaysia (2005), the components in the consumer price index (CPI) for health in Malaysia consist of pharmaceutical products, other medical products (e.g. cotton wool, condom, contraceptive pills, pregnancy tests, etc.), therapeutic appliances and equipments (e.g. spectacles, contact lenses, hearing aids, etc.), medical services, dental services, paramedical services (e.g. X-ray and scanning, homeopathy, health massage, acupuncture, etc.), and hospital services or inpatient at government hospital, government corporate hospital and private hospital.

TABLE 1. THE RESULTS OF UNIT ROOT TESTS

Variables	ADF	PP
$\ln HE_t$	-4.952 (3)***	-3.031 (3)
$\Delta\ln HE_t$	-4.675 (3)***	-4.334 (4)***
$\ln Y_t$	-2.009 (1)	-1.890 (1)
$\Delta\ln Y_t$	-4.726 (0)***	-4.710 (2)***
$\ln RELP_t$	-1.934 (0)	-1.937 (2)
$\Delta\ln RELP_t$	-6.250 (0)***	-6.250 (0)***

Note: The asterisks *** represent the significance level at the 1 per cent. ADF and PP refer to Augmented Dickey-Fuller and Phillips-Perron unit root tests respectively. 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).

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 care spending ($\ln HE_t$). While, PP unit root test cannot reject the null hypothesis of a unit root at level for all the variables included health care 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 ($\ln Y_t$) and relative price ($\ln RELP_t$) are integrated of order one process, but health care spending is integrated of order zero (i.e. stationary at level). On the contrary, PP test demonstrate that all variables included health care 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 Zanoli (1993) and Obben (1998) noted that if the ADF and PP results are inconsistent, the results of PP test is preferred because it is more powerful than the ADF test in particular when the estimates sample is small. Therefore, we surmise that the estimated variables are integrated of order one $I(1)$ process.[5] 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.

[5] 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 unit root 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.

2. Cointegration Test

In this section, we test the presence of long-run equilibrium relationship between health care spending, income and relative price 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, W_t is $(n\times 1)$ of endogenous variables [ln HE_t, ln Y_t, ln $RELP_t$]$'$ and each of the A_i is an $(n\times n)$ matrix of parameters. The deterministic term D_t contains constants, a linear terms or seasonal dummies. $\Gamma = -(I - A_1 - \cdots - A_i)$, $(i=1,\ldots,k-1)$ 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 in order to avoid the small sample bias problem.

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 is well performs than any other information criterions (e.g. Schwarz Bayesian Criterion and Hannan-Quinn) when the estimated sample size is relatively small (e.g. less that 60 observations). The AIC statistic indicates that 3 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

TABLE 2. THE RESULTS OF MULTIVARIATE JOHANSEN COINTEGRATION TEST

Hypothesis		LR tests statistics	Adjusted critical values#	
H_0	H_A		5 per cent	10 per cent
$LR(\lambda_{trace})$				
$r=0$	$r\geq 1$	34.386*	37.3773	33.7478
$r\leq 1$	$r\geq 2$	7.797	19.4065	16.7870
$r\leq 2$	$r\geq 3$	3.049	4.7351	3.3876
$LR(\lambda_{max})$				
$r=0$	$r=1$	26.589**	26.5800	23.5759
$r\leq 1$	$r=2$	4.748	17.8341	15.2990
$r\leq 2$	$r=3$	3.049	4.7659	3.4096

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

$LR(\lambda_{max})$. At the 5 per cent significance level, the $LR(\lambda_{trace})$ statistic cannot rejects the null of no cointegrating vector ($r=0$), while $LR(\lambda_{max})$ statistic rejects the null of no cointegrating vector. At the 10 per cent significance level, both LR statistics consistently exhibit that there is one cointegrating vector among the three variables. As a result, we conclude that there is a long-run equilibrium relationship between health care spending, income and relative price in Malaysia.

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:

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

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

$$\Delta\ln RELP_t=\alpha_3+\sum_{i=1}^{k}\varphi_i\Delta\ln RELP_{t-i}+\sum_{i=0}^{k}\delta_i\Delta\ln HE_{t-i}+\sum_{i=0}^{k}\phi_i\Delta\ln Y_{t-i}+\psi_3 ECT_{t-1}+\mu_{3t} \quad (4)$$

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), $\delta_i=0\ \forall_i$

TABLE 3. THE RESULTS OF GRANGER CAUSALITY

Dependent variable	Likelihood Ratio (LR) statistics			ECT_{t-1} [t-statistics]
	$\Delta\ln HE_t$	$\Delta\ln Y_t$	$\Delta\ln RELP_t$	
$\Delta\ln HE_t$	–	4.789	14.025***	−0.692 [−4.362]***
$\Delta\ln Y_t$	0.002	–	5.300**	−0.046 [−1.837]*
$\Delta\ln RELP_t$	7.666	14.921***	–	−0.124 [−1.249]

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

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 relative price 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 relative price to health spending in the short-run at the 1 per cent level. In addition, the results show that there is a bi-directional Granger causality between relative price and income in the short-run. Ironically, the short-run Granger causality between health spending and income tend to be neutral. This indicates that health spending and income are not related in the short-run because the interrelationship between health and income are indirect as discussed by Grossman (1972) and Bloom and Canning (2000), hence it take time to affect each other. 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 10 per cent level in equations when health spending and income is the dependent variable. However, ECT_{t-1} is statistically insignificant when relative price is the dependent variable. This implies that health spending and income are bi-directional Granger causality in the long run, while relative price in Malaysia uni-directional Granger causality health spending and income in the long-run. This result supports the health-led growth hypothesis in Malaysia as a long-run phenomenon. Moreover, 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 long-run.

IV. *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 shocking each variable in the system with one-standard deviation. Several interesting findings emerged from the variance decomposi-

Table 4. The Results of Variance Decompositions Analysis

Relative variance of health

Years	Health	Income	Relative Price
1	100.00	0.00	0.00
2	98.63	0.65	0.72
3	96.23	1.89	1.88
4	93.54	3.41	3.05
5	91.03	4.97	4.00
10	83.60	10.87	5.52
15	80.64	13.99	5.37

Relative variance of income

Years	Health	Income	Relative Price
1	0.71	99.29	0.00
2	0.86	98.52	0.62
3	2.17	96.25	1.58
4	3.84	93.60	2.56
5	5.49	91.05	3.46
10	10.96	82.82	6.22
15	13.34	79.27	7.39

Relative variance of relative price

Years	Health	Income	Relative Price
1	4.15	14.03	81.82
2	4.05	14.00	81.95
3	3.98	13.97	82.05
4	3.92	13.96	82.12
5	3.89	13.94	82.17
10	3.82	13.90	82.28
15	3.82	13.88	82.30

Note: Cholesky ordering: health, income and relative price of health care

tion results. In the short-run, health spending is the most exogenous variables, follow by income and relative price. After two years, 98.6 per cent, 98.5 per cent and 81.9 per cent of the variation in the forecast error variance for health spending, 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 Granger-cause each other in the long-run. In explaining the shocks to health spending, income is more important than relative price in long-run, while in the short-run relative price is more important than income. In addition, income is also more important than health spending in explaining shocks to relative price in both the short-run and the long-run. In explaining the shocks to income (economic growth), health spending is relatively more important than relative price in the long-run. After 10 years, 11 per cent of the variation in income can be explained by health spending, while relative price only explained 6.2 per cent of the variation in income. However, the forecast error variance for health spending and relative price increases to 13.3 per cent and 7.4 per cent, respectively after fifteen years. Therefore, health spending play more important role than relative price in generating long-term growth in Malaysia. This is consistent with the finding of Granger causality results presented in Table 3.

Fig. 2. Impulse Responses of Health to a One-standard Deviation Shock in Health, Income and Relative Price

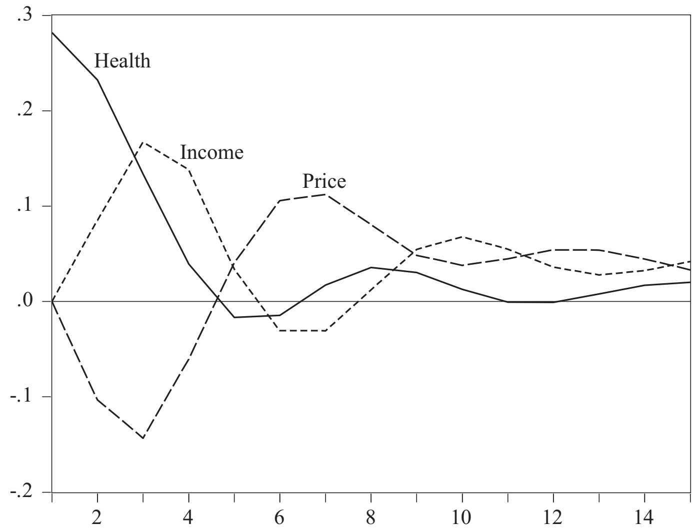
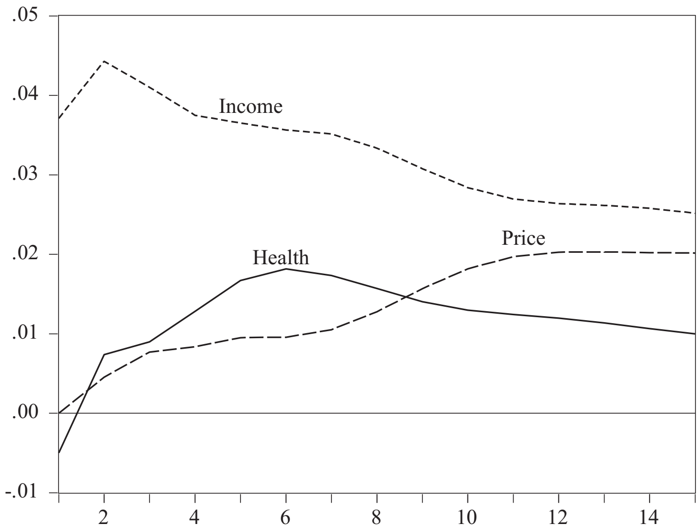
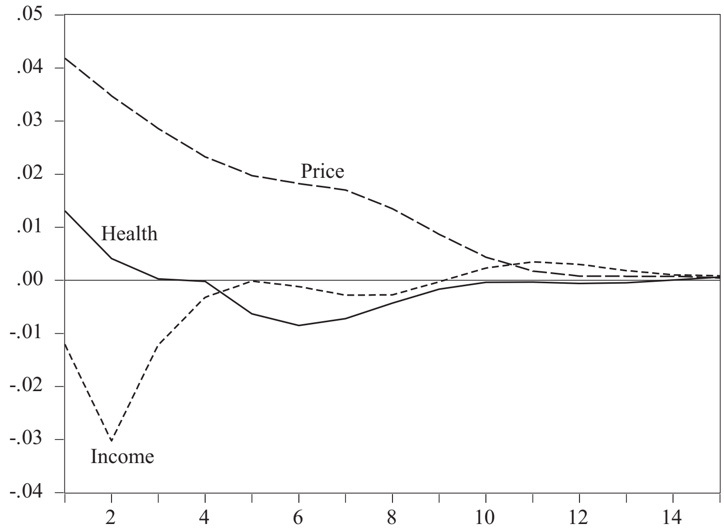


Fig. 3. Impulse Responses of Income to a One-standard Deviation Shock in Income, Health and Relative Price



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

FIG. 4. IMPULSE RESPONSES OF RELATIVE PRICE TO A ONE-STANDARD DEVIATION SHOCK IN RELATIVE PRICE, INCOME AND HEALTH



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 relative price to a one-standard deviation shocks in health spending, income and relative price over a 15 years period are illustrated in Figure 2 to Figure 4.

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 relative price decreases health spending in the first three years, thereafter it fluctuate around the positive level before stabilising after year seven. This implied that a shock to relative price exerts a positive effect on health spending in Malaysia. Turning to Figure 3, a shock to health spending and relative price have positive impact on income over the fifteen years. From Figure 4, it can be seen that a shock to income increase relative price after two years and stabilise thereafter. On the other hand, a shock to health spending decreases relative price in the first six years and stabilise thereafter.

V. *Conclusion, Policy Recommendations and Limitations*

Given that healthy society is more productive and efficient in generating economic growth and development, the interaction between health spending, income and relative 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 relative 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 long-run equilibrium relationship between health spending, income and relative 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 relative price to health spending and bi-directional Granger causality between relative price to income growth in Malaysia. While, in the long-run health spending and income are Granger-cause each other, but there is uni-directional Granger causality running from relative price to health spending and income in Malaysia.

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 relative 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 the long-run.

In view of policy recommendations, the findings of this study suggest that health spending plays an important role in promoting long-term 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 individuals are more productive in relative to 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.

No one is perfect and this study is no exception. First, this study looks at the macroeconomic perspective per se and can only provide a general idea of the relationship between health care spending, income and relative price of health care in Malaysia. We couldn't deny the fact that this is the main limitation of any macroeconomics analyses. Thus, it would be more precise and interesting if the micro level data such as household survey data are use to analyse this topic. Second, as noted in the earlier section of the paper, this study is a country-specific study, therefore the findings of this study may not be generalised for other countries, but it is very useful for country-specific policymaking.

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