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What Derives Public Health Expenditures in Saudi Arabia? Macro-Econometric Analysis

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Abstract: ***This study aims to investigate the short and long-term relationships of the public healthcare expenditures with its determinants in Saudi Arabia, over the period from 1980 to 2013. The study results show that there exist positive and significant long term relationships between gross domestic product (GDP), number of physicians per 1000 population, health consumer price index (CPI), and percent of population aged 65 or elder with public health expenditures. The results of the error correction model (ECM) also confirm that all the explanatory variables have significant effects on the level of public health expenditures, except health CPI due to its slow growth rate during the study period. Moreover, the model results indicate that whenever the system is out of equilibrium, it is restored back with speed of about 81.6 percent in a year. The results of both short and long-term models confirm that health is a necessity in Saudi Arabia and not a luxury good. Based on these results, the study provided three recommendations to improve the public health services.***

Keywords: Saudi Arabia, Public health expenditures, stationarity, cointegration, long run equilibrium model, Error Correction Model.

1. Introduction

The government of Saudi Arabia strives to provide high quality healthcare services to the public. It continues to adopt policies and measures that meet the growing demand for healthcare services and the increasing costs of these services. As a result, the healthcare services have improved during the past decades (Almalki, Fitzgerald and Clark, 2011).

The government is the main provider for healthcare services, contributing by about 81 percent of the total health expenditures (WHO, 2015).The health expenditure on goods and services was 23.5 billion US dollars in 2013; representing an increase of 276.5 percent compared with 2003(Ministry of Economy and Planning, 2013). The total government health expenditures amounts to 3.2 percent of gross domestic product (GDP) in 2013compared with less than 1 percent in 1980 (Ministry of Economy and Planning, 2013). The private health expenditures was 1.1 percent of the GDP in 2013 (World Bank, 2015). The percent of total health expenditures to GDP (4.3 percent) is below its level in many industrialized countries. For example, in 2013 USA allocated 17 percent of its GDP to healthcare services, European Union countries spent about 10 percent of its GDP on healthcare services and Australia spent 9 percent of its GDP on healthcare services (World Bank, 2015).

In terms of individual's expenditure, the per capita health expenditure was 808 US $ in 2013; which is twice the average per capita health expenditure in Middle East and North Africa countries (World Bank, 2015). However, the per capita health expenditure in Saudi Arabia is much lower than that of many developed countries; it is about only 8 percent of per capita health expenditures in Norway and 9 percent to that of USA (World Bank, 2015)

Currently, healthcare services are provided free of charge to all Saudi nationals and expatriates working in the government agencies through a network of public hospitals and primary healthcare centers. In addition, Saudi citizens and expatriates working in the private sector and their families receive healthcare services in private health institutions through health insurance coverage paid by their employers.

The basic health indicators reveal that the residents in Saudi Arabia enjoy good health with high life expectancy and low mortality rates. The life expectancy at birth was 75 year in 2013, exceeding the regional average by 7 years and the world average by 5 years (Ministry of Health, 2013). The crude death rate was 3.2 per thousand population in 2013, lower than that of USA (8.2 deaths per 1000 population) and that of United Kingdom (9 deaths per 1000 population) (World Bank, 2015).

A review of the relevant literature shows that the macro-level factors influencing health expenditures vary across countries. However, there are many common factors responsible for the increasing trend of health expenditures. The national income, population growth, population aging, health policies, medical technological progress, health service facilities, healthcare personnel, lifestyle patterns, growing consumer demand are the most common cited macro-level derivers for health expenditures in many countries (Newhouse, 1977, Meijer, Wouterse, Polder, and Koopmanschap, 2013; Martins and Maisonneuve, 2006; Sorenson, Drummond, and Khan, 2013; Walston, Al-Harbi and Al-Omar, 2008).

The main objective of this study is to investigate the short and long-term relationships of the public healthcare expenditures with its determinants in Saudi Arabia. The specific objectives are as follows:

- To understand the nature of the relationship between public health expenditures and its determinants in Saudi Arabia.
- To estimate the elasticity of public health expenditure with respect to GDP and other health expenditure drivers.

The remainder of this article is organized as follows. The following section demonstrates the determinants of public healthcare expenditures model. Afterwards, mode estimation

results, conclusions, and policy recommendations are presented.

2. The Determinants of Public Healthcare Expenditures Model

2.1 Selection of Model Variables

Prior research results show that the determinants of healthcare expenditure vary across countries. However, there are many common variables have direct and indirect effects on public health care expenditure, which is in this research refers to expenditure incurred by the Saudi government on health care services. The following are the most common macroeconomic and demographic variables cited in the literature that influence health care expenditures:

1) GDP: GDP or Per capita GDP has been identified by many studies as the main driver of health expenditure in many countries (See for example Newhouse, 1977;Di Matteo, 2005; Sen, 2005; Souliotis et al 2014; Maciejewski, Liu, Kavee and Olsen, 2012; Kowaslki, 2013; Wang and Rettenmaier, 2006; Mehrara, Fazaeli, Fazaeli and Fazaeli, 2012). In all these studies, total GDP or GDP per capita was used as explanatory variable of the health expenditures whether per capita or total.
2) Population: Some studies have shown that health expenditure is related to population growth, as the amount of investment in public health care in many countries increases with the increase of population (Sülkü and Caner, 2009; Kiymaz, Akbulut and Demir, 2006; Odubunmi,SakaandOke, 2012).
3) Population age structure variables: Population age structure variables have been included as predictors in health expenditure regression models. The most common age variables are the proportions of young and old population ((Leu 1986; Hitiris and Posnett 1992; Di Matteo & R. Di Matteo 1998; Huang, 2004; Souliotis et al 2014; Murthy and Ukpolo, 1994; Getzen, 2004). The inclusion of these variables is attributed to the increased health cost of these two categories (Fujino, 1987; Murthy and Ukpolo, 1994, Rechel et al, 2009). In this study, percent of population aged 65 years and older is used as an explanatory variable for public health expenditures. The data on percent of population less than 5 or 15 years were either unavailable for the whole study period or available as estimates for most years.
4) Number of physicians: As healthcare is a labor intensive industry, the number of physicians has been used as a determinant of healthcare expenditures in many studies, representing the induced demand for healthcare services (Murthy and Ukpolo, 1994; Huang, 2004; Souliotis et al 2014). Therefore, as the number of physicians grows the health expenditures increases. In this study the number of physicians per 1000 population is used as an explanatory variable for public health expenditures.
5) Healthcare consumer price index (CPI). Health CPI as a proxy for health care prices is considered by some authors as one of the healthcare cost drivers (Imoughele and Ismaila, 2013; Dhoro, Chidoko, Sakuhuni and Gwaindepi, 2011).
6) Number of pilgrims coming from outside Saudi Arabia: The Saudi Ministry of Health provides healthcare to all pilgrims during Hajj season, which extends from one to three months for those coming from abroad. The annual number of pilgrims coming from outside Saudi Arabia ranged between 0.7 to 1.8 million during the study period. However, no prior research studied the effect of pilgrims coming from outside Saudi Arabia on the public health expenditures.

2.2 Sources of Data

In this study, annual time series data for the period 1980-2013 were obtained from different sources. These main sources are the 30th edition of achievements of the development plans: Facts and Figures (1970-2013) published by Ministry of Economy and planning, annual reports of Saudi Arabian Monetary Agency and Health statistics annual books published by the Saudi Ministry of Health (Ministry of Economy and Planning, 2013; Ministry of Health, 2013).

2.3 Model Specification

In line with the previous research results, a macro determinant of health expenditures model may be written as follows:

$$\ln(\text{phe})_t = \beta_0 + \beta_1 \ln(\text{gdp})_t + \beta_2 \ln(\text{pop})_t + \beta_3 \ln(\text{phy})_t + \beta_4 \ln(\text{cpi})_t + \beta_5 \ln(\text{pop65})_t + \beta_6 \ln(\text{pilg})_t + \varepsilon_t \quad (1)$$

where:
phe = public health expenditure in Saudi Riyals at year t (t=1980, .., 2013).
gdp = GDP in Saudi Riyals at year t
pop = Population at year t
phy = number of physicians per 1000 population at year t
cpi = Healthcare consumer price index at year t
pop65 = Percent of population aged 65 years and older at year t
pilg = Number of pilgrims at year t
ε_t = white noise error term.

The dependent and explanatory variables were transformed to natural logarithms so that the regression coefficients directly reflect the elasticities as well as to reduce the problem of heteroscedasticity (Chatterjee and Hadi, 2013; Fahrmeir, Kneib, Lang and Marx, 2013).

2.4 Unit Root Tests for the Research Variables

Tests for stationarity and cointegration of time-series data are pre-test to avoid spurious regression. Therefore, unit root tests were performed using Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP). The results presented in Tables 2 and 3 show that the variables are non-stationary at levels but are stationary at first difference. Hence the research variables are I(1) processes, that is they have stochastic trends.

Table 2: Unit root tests for the research variables

Variable	Intercept		Intercept and trend	
	T	p-value	T	p-value
Augmented Dickey-Fuller Test:				
Health expenditure	.9	.993	-1.1	.941
GDP	1.5	.999	-1.8	.665
Population	-1.2	.663	-2.9	.168
Number of physicians per 1000 population	-1.0	.745	-1.2	.888
CPI	-0.3	.923	-1.4	.851
Percent of population aged 65 or elder	-2.7	.093	-3.0	.146
Number of pilgrims	-.9	.774	-2.7	.258
Phillips-Perron Test:				
Health expenditure	1.8	.995	-0.8	.957
GDP	1.3	.998	-1.8	.667
Population	-1.7	.444	-2.2	.483
Number of physicians per 1000 population	-1.4	.563	-1.8	.671
CPI	-0.4	.905	-1.4	.851
Percent of population aged 65 or elder	-1.6	.451	-2.0	.559
Number of pilgrims	-1.1	.719	-2.5	.332

Table 3: Unit root tests for First Difference of the research variables

Variable	Intercept		Intercept and trend	
	T	p-value	T	p-value
Augmented Dickey-Fuller Test:				
Health expenditure	-4.6	.001	-5.1	.002
GDP	-4.1	.003	-5.3	.001
Population	-4.6	.001	-4.5	.006
Number of physicians per 1000 population	-3.8	.007	-3.7	.035
CPI	-4.2	.002	-4.2	.013
Percent of population aged 65 or elder	-6.6	.000	-5.5	.001
Number of pilgrims	-7.4	.000	-7.2	.000
Phillips-Perron Test:				
Health expenditure	-4.6	.001	-8.9	.000
GDP	-4.2	.003	-5.3	.001
Population	-4.6	.001	-4.5	.006
Number of physicians per 1000 population	-3.9	.006	-3.8	.029
CPI	-4.2	.002	-4.2	.014
Percent of population aged 65 or elder	-4.7	.001	-4.8	.003
Number of pilgrims	-7.4	.000	-7.2	0.000

3. Model Estimation Results

Long-Run Model:

Before building long-run regression model, pairwise Pearson correlation coefficients between the study variables were computed. The results presented in table 3 shows there are strong positive significant correlations between all explanatory variables at 1 and 5 percent levels of significance except the correlations between the percent of population aged 65 years and older with number of physicians per 1000 population and with health consumer price index.

Table 3: Correlation matrix of the research variables

Variable	phe	gdp	pop	phy	cpi	pop65
gdp	.949*** (.000)					
pop	.899*** (.000)	.817*** (.000)				
phy	.637*** (.000)	.555*** (.001)	.731*** (.000)			
cpi	.893*** (.000)	.840*** (.000)	.905*** (.000)	.839*** (.000)		
pop65	.541*** (.001)	.444*** (.008)	.430** (.011)	-.171 (.334)	.218 (.216)	
pilg	.906*** (.000)	.884*** (.000)	.862*** (.000)	.431** (.011)	.763*** (.000)	.632*** (.000)

***significant at 0.01 level, **significant at 0.05 level

The high interrelationship between the explanatory variables signals for the problem of multicollinearity. Therefore, a stepwise regression method was used to overcome the problem of multicollinearity (Brown, 1998; Black, 2012; Wheeler, Shaw, and Barr, 2013). Table 4 presents the results of full long-run model where all the explanatory variables were included and the results of stepwise selection method. The full long-run model shows that population, CPI and number of pilgrims do not contribute significantly in explaining the annual variation of public health expenditures, as their respective p-values are strictly greater than .05. Moreover, the corresponding variance inflation factor (VIF) values are greater than 10, a common rule of thumb, which implies that the model suffers from a multicollinearity problem.

As for the stepwise method selection, the results show there are four variables, which have significant effects on the public health expenditures; their respective p-values are less than .05. Moreover, the results show that there is no severe multicollinearity, as the VIF values are less than 10 except that of CPI, which is almost equal to 10. Despite the exclusion of two variables, population and number of pilgrims, the adjusted coefficient of determination $\bar{R}^2$ remain the same in the reduced model, .981.

Table 4: Regression models results of full and reduced models

Variable	All Variables				Stepwise Selection Method			
	$\hat{\beta}$	t	p-value	VIF	$\hat{\beta}$	t	p-value	VIF
Constant	-7.508	-3.2	.004	-	-11.623	-3.7	.001	-
Gdp	.629	7.3	.000	7.4	.685	10.8	.000	4.1
Pop	-.259	-1.1	.269	14.2	-	-	-	-
Phy	1.548	4.2	.000	8.9	1.281	4.1	.000	6.6
Cpi	.020	1.9	.057	14.1	1.799	2.1	.043	10.4
pop65	.970	7.2	.000	3.4	.921	8.9	.000	2.1
Pilg	.239	1.0	.324	11. 3	-	-	-	-
F(6,27)=278.5, p-value =.00; R^2 =.984 ; $\bar{R}^2$ =.981					F(4,29)=419.7, p-value =.00; R^2 =.983 ; $\bar{R}^2$ =.981			

The fitted long-run regression model is as follows:

$$\widehat{PHE}_t = -11.623 + .685\ GDP_t + 1.281phy_t + 1.799cpi_t + .921pop65_t \quad (2)$$

The fitted model was checked against the linear regression assumptions of normality, homoscedasticity and autocorrelation. The results shown in table5 confirm that these assumptions were not violated. Hence, the model fits the data very well.

Table 5: Long-run model diagnostic tests

Assumption	Test	Test statistic	P-value
Normality	Jarque-Bera	χ^2 = 1.17	.558
Homoscedasticity	Breush-Pagan-Godfrey	F-statistic = 2.58	.060
Homoscedasticity	Harvey	F-statistic = 1.03	.409
No autocorrelation	Durbin-Watson	DW = 1.42	$d_L < DW = 1.45 < d_U$
No autocorrelation	Breusch-Godfrey	F-statistic=1.13	.337

Furthermore, to confirm whether the fitted model is spurious or not, a unit root test was carried for its residuals as shown in Table 6. The p-values corresponding to ADF and PP tests for both intercept and intercept and trend are strictly less than .01, implying that the residuals are stationary, that is they are I(0). This result confirms that there is a long-term or equilibrium relationship between the public health expenditure and its four derivers in Saudi Arabia.

Table 6: Unit root tests of long-run model residuals

Variable	Intercept		Intercept and trend	
	T	p-value	T	p-value
Augmented Dickey-Fuller Test:	-4.9	.000	-4.9	.002
Phillips-Perron Test:	-4.9	.000	-4.9	.002

The results of the long-run model show that GDP, physicians per 1000 population, health CPI, and proportion of population aged 65 years or over have significant effects on public health expenditures; p-values are less than .05. These four variables explain 98.1% of the annual variation in the public health expenditures.

The model results show that as GDP increases by 1 percent, on average the public health expenditure goes up by .0.685percent holding the other variables constant. Moreover, the elasticity of is less than 1 which implies that health is a necessity in Saudi Arabia and not a luxury good (Antonides, 2008; Henderson, 2014). These results go in line with the results of many studies carried in different Asian, Middle East and other developing countries (Lv and Zhu, 2014; Sülkü and Caner, 2011; Ke, Saksena, and Holly, 2011; Odoh and Nduka, 2014; Mehrara, Fazaeli, Fazaeli and Fazaeli, 2012, Huang, 2004). However, this result contrasts with the results of many studies carried in developed countries, where the

elasticity was found to be greater than one (Newhouse, 1977; Okunade and Murthy, 2002).

Similarly, a one percent increase in the number of physicians per 1000 population tends to increase the public health expenditure by about 1.3 percent. The results also show that as the health CPI increases by 1 percent the public health expenditure increases by 1.8 percent. Lastly, the increase in the proportion of population aged 65 years or over by one percent leads to an increase of almost one percent in the public health expenditures keeping other variables constant. These results are consistent with the previous studies, which found that increases in number of physicians, CPI, the proportion of population aged 65 years or over lead to increased health expenditures (Hitiris and Posnett 1992; Di Matteo & R. Di Matteo 1998; Huang, 2004; Murthy and Ukpolo,1994;Getzen, 2004 Souliotis et al 2014;Imoughele and Ismaila, 2013; Dhoro, Chidoko, Sakuhuni and Gwaindepi, 2011, Furuoka et al., 2011).

A Short-run Error Correction Model

To estimate both short and long-run relationship between public health expenditures and its determinants an error correction model (ECM) wasbuilt. The ECM relates the short run changes in the public health expenditures to the short run changes in the independent variables, linking these with the changes to the long run effect through the feedback mechanism. Moreover, the speed of adjustment toward the long-run values can directly be estimated.

The ECM requires first testing for stationarity of variables to determine their order of integration followed by cointgeration test to explore the possibility of long-run equilibrium relationship between the dependent and the explanatory variables and then depending on the existence of long-run relationship, an error correction model will be estimated.

Johansen co-integration test

In addition to residuals-based test for cointegration, Johansen co-integration test was carried since the research variables are stationary at their first difference, *I*(1).The Johansen test detects a number of cointegration vectors in non-stationary time series. Table 7 summarizes the results of Johansen cointegration test based on the five assumptions of the deterministic components in the data or the cointegration equations.

Table 7: Number of cointegrating vectors based on Johansen cointegration test for public health expenditure model

Data Trend:	Test Type	Trace	Max-Eigen value
None	No Intercept, No Trend	3	2
None	Intercept, No Trend	5	2
Linear	Intercept, No Trend	5	2
Linear	Intercept, Trend	3	3
Quadratic	Intercept, Trend	3	4

The results show the presence of long-run relationship between the research variables. The Johansen cointegration test suggests the existence of at least two cointegrating vectors in most cases.

Based on the results of unit root tests of long-run model residuals and the Johansen cointegration test, an error correction model was estimated. The model takes the following form:

$$\Delta \mathrm{PHE}_t = \delta_0 + \sum_{i=1}^{L1} \delta_{1i} \Delta \mathrm{GDP}_{t-i} + \sum_{j=1}^{L2} \delta_{2j} \Delta \mathrm{phy}_{t-j} + \sum_{h=1}^{L3} \delta_{3h} \Delta \mathrm{cpi}_{t-h} + \sum_{k=1}^{L4} \delta_{4k} \Delta \mathrm{pop65}_{t-k} \quad (4)$$
$$+ \lambda EC_{t-1} + \nu_t$$

where

L1 to L4are the optimal number of lags determined by Schwarz Information Criterion.

$\delta_{1i}, \delta_{2j}, \delta_{3h}, \delta_{4k}$ are short-run elasticities of the four variables respectively

λ is the coefficient of error component and measures the speedat which prior deviations from equilibrium are corrected.

ν_t is white noise

Table 8 shows the results of the error correction model. The results shown in table 9 confirm that all the assumptions of normality, no autocorrelation, homoscedacity and no multicollinearity were not violated; the respective tests' p-values are greater than .05. Hence, the fitted model is consistent and reliable.

Table 8: Error correction model results (Dependent variable:ΔPHE)

Coefficient	$\hat{\beta}$	t	p-value	VIF
Constant	0.021	.9	0.400	-
Δgdp	0.509	3.5	0.002	1.0
Δphy	1.158	2.6	0.016	1.3
Δcpi	1.473	1.4	0.161	1.2
Δpop65	0.644	2.7	0.011	1.4
EC_{t-1}	-0.816	-4.6	0.000	1.2
F = 8.5, p-value =.00; R^2 = .612 ; $\bar{R}^2$ = .540				

Table 9: Dynamic model diagnostic tests

Assumption	*Test*	*Test statistic*	*P-value*
Normality	Jarque-Bera	χ^2 = .811	.667
Homoscedasticity	Breush-Pagan-Godfrey	F-statistic = .268	.977
Homoscedasticity	Harvey	F-statistic = .789	.629
No autocorrelation	Durbin-Watson	DW = 1.76	$d_U < DW = 1.76 < 4 - d_L$
No autocorrelation	Breusch-Godfrey	F-statistic=1.04	.368

The results show that all the explanatory variables are significant at .05 level, except the CPI, which its p-value is greater than .05. This result implies that the health CPI has no significant effect on the public health expenditure in short-run despite its long-run effect. This result was expected, as the CPI for health has been growing slowly during the study period with annual rate of 1 percent.

The model results show the algebraic sign of the error correction model (EC_{t-1}) is negative and significant at .01 level, satisfying a priori expectation. This indicates that there is also short run relationship between public health expenditure and its determinants. The EC_{t-1} coefficient shows that whenever the system is out of equilibrium, it is restored back with a speed of about 81.6 percent in a year. It means that about 82 percent departures from previous year's disequilibrium adjust back to the equilibrium in the current year. The speed adjustment is high.

The long-run elasticity of GDP is .685, which is greater than the short-run elasticity of .509. This designates that inelasticity of public health expenditure with respect to income in short and long-run terms. Moreover, the long-run income elasticity is larger than the short-run, indicating that public health expenditures is income elastic. For short-run the health CPI is the only non-significant variable in its effect on public health expenditures.

4. Conclusions and Policy Recommendations

This study aims to investigate the short and long-term relationships of the public healthcare expenditures with its determinants in Saudi Arabia, over the period from 1980 to 2013. Based on the literature review and the availability, six variables were identified as the main drivers of public health expenditures; GDP, population, number of physicians per 1000 population, health CPI, percent of population aged 65 or elder and the number of outside pilgrims. The tests for stationarity show that both the dependent and the explanatory variables are non-stationary at levels but are stationary at first difference.

Due to the high interrelationships between the explanatory variables, a stepwise regression method was used to overcome the problem of multicollinearity. The results of the parsimonious model show that there are four variables which have significant effects on the public health expenditures; GDP, number of physicians per 1000 population, health CPI, and percent of population aged 65 or elder. Furthermore, the results of the unit root tests show that the residuals of the fitted model are stationary, implying that there is a long-term or equilibrium relationship between the public health expenditure and its four derivers in Saudi Arabia. In the long-run, increases in GDP, number of physicians, CPI and in percent of elderly people lead to increased public health expenditures. Moreover, an error correction model was built to link the short run dynamics to a long run equilibrium relationship, which determines the public health expenditures. The results show that all the explanatory variables have significant effects on the level of public health expenditures, except health CPI due to its slow growth rate during the study period. This implies that the health CPI has no significant effect on the public health expenditure in the short-run despite its long-run effect. In addition, the model results indicate that whenever the system is out of equilibrium, it is restored back with a speed of about 81.6 percent in a year.

Based on these results, the study suggests the following recommendations to enhance the public health services in Saudi Arabia:

- Despite the high growth in public healthcare spending, the study results show that health is a necessity good. This reveals that there is a need to increase health expenditures to meet the increasing healthcare demand. In this regard, policy makers need to plan for the role of private in provision of healthcare services.
- In the short-run, health CPI has no significant effect on public health expenditures, in spite of its long-run effect. Therefore, there is a need to take into consideration when budgeting for health care services the past and current inflation levels particularly the health CPI.
- The parsimonious long-run model excluded the number of outside pilgrims and population as drivers for health expenditures. However, planning to provide healthcare services should take into consideration the population size and the number of outside pilgrims, as Saudi Arabia is a recipient of millions of foreign workers and outside pilgrims. This also necessitates closed coordination between ministry of economy and planning, ministry of finance and ministry of labor.

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