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Time Series Analysis of Determinants of Health Care Expenditure in Iran: A Bound Test Cointegration Approach

Mohsen Bayati [1], Mohammad Hossein Ziloochi [2], Somayeh Delavari [3], Sajad Delavari [1*]

[1] Health Human Resources Research Center, School of Management & Information Sciences, Shiraz University of Medical Sciences, Shiraz, Iran
[2] Health Information Management Research Center, Kashan University of Medical Sciences, Kashan, Iran
[3] Department of Medical Education, School of Medical and Center for Educational Research in Medical Sciences(CERMS), Iran University of Medical Sciences, Tehran, Iran

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***Corresponding Author:**
Sajad Delavari
Health Care Management & Informatics School Almas Building, Alley 29, Qasrodasht Ave, Shiraz, Iran**.**
Email:
sdelavari@sums.ac.ir

Tel:
+98-71-32340774

ABSTRACT

Background: specifying the determinants of healthcare expenditure is one of the most important challenges in the health sector. The current study was aimed to assess factors affecting government health care expenditure in Iran.
Methods: to identify short-term and long-term determinants of healthcare expenditure in Iran during 1971-2007, Auto Regressive Distributive Lag (ARDL) bound testing approach to co integration was used. The explanatory variables were defined into economic, demographic and supply side categories. The data were collected from the official websites of the Iranian Statistics Centre, Central Bank of Iran, and the Ministry of Health.
Results: we found health care expenditures as necessary goods in both short-term and long-term. In long-term, per capita income (β = 0.815, P-value = 0.033), elderly population (β = - 1.790, P-value < 0.001), and physician density (β = 3.204, P-value = 0.004) had effect on health care expenditure. In short-term per capita income (β = 0.577, P-value = 0.026) was the only factor that significantly affected health care expenditure.
Conclusion: Government health expenditure is necessary goods in both short and long run. Thus governmental health care expenditure does should grow proportional to increase in national income. This could result to decrease in out of pocket payment.

Keywords: Health Care Expenditure, Income Elasticity, Time Series Analysis, Co integration, ARDL Model

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Introduction

Since 1960s, in many industrial economies, the share of health care expenditure in GDP has attracted the attention of economic researchers. Share of health care expenditure in GDP is generally low in developing countries as compared with developed countries. On average countries with very high human development index, spend 12.2 percent of their GDP on healthcare, while this ratio is 6 percent and 4.2 percent for the countries with high and medium human development index, respectively (1).

In Iran, 5.3 percent of GDP is spent on health. Meanwhile, people pay about58 percent of total health care expenditure directly (2). Although a remarkable amount of GDP is devoted to the public health, the ministry of health, social security organization and other governmental organizations contribute only 40 percent of total resources devoted to health. This issue is criticized regarding the equity aspects (2, 3).

Factors such as increase in the demand for health services, the emergence of new technologies in medicine, and aging have rapidly increased the health care expenditure in terms of both absolute rate and its growth rate relative to the GDP growth (4-6).

Therefore, specifying the effective factors on health care expenditure gives useful information to policymakers to make realistic policies in order to improve the society health as well as better use of governmental resources.

Many studies investigated determinants of health care expenditure at micro and macro levels by different methods. Most of these researches have been done in developed countries.

Literature Review

For the first time Newhouse (1974) raised the question about determinants of the quantity of resources in the medical care in a country. In his study, the basic variables were the centralisation degree in providing healthcare and the way of reimbursement to the providers. He also examined the relationship between health care expenditure of countries and their income. The income elasticity of health care expenditure was estimated greater than unity (luxury good) in his study. He concluded the difference in per capita income was the main reason of the difference in the health care expenditure among countries (7).

Magazzino and Mele (8) examined the determinants of health care expenditure in Italy at the state level by panel methodologies. The results indicated the income elasticity is below the unity according to both the static panel estimates and the dynamic estimates .

Prieto and Lago-Peñas (9) estimated the effective factors on per capita government health care expenditure including real per capita income, number of beds per 1000 persons, number of general physicians per 1000 persons and the population age using the panel data (time interval 1992 to 2005 in 18 regions of Spain) by fixed effects.

Yavuz etal (10) studied the determinants of health care expenditure in Turkey over the period 1975–2007 by using ARDL bounds test approach to the co integration. They estimated the short-run and long- run effect of income, demand side variables and supply side variables on per capita health care expenditure. The results showed that income has no effect on health care expenditure in the long-run but it is a necessity good in the short run.

Based on literature, effective factors on health expenditure can be classified in three categories:

A) Economic variables: the most important variable is income. The relation between national healthcare expenditure (HCE) and gross domestic product (GDP) has been the subject of various experimental studies (11-13). Most of the studies have stated a positive relation between income and health care expenditure but there is no consensus on income elasticity of health care expenditure. Foreign aid (14), relative price of health care (15-18), unemployment rate (19, 20),share of deficit to GDP (21) and federal transfers (22)are other mentioned economic factors.

B) Demographic variables: age structure of the population is the most important one of these variables (9,23-25).Usually children and elderly need more healthcare services and therefore these parts of the population may affect the healthcare expenditure. Urbanization rate(18,26), dependency ratio (27), and population growth rate can be referred as other demographic variables.

C) Variables related to healthcare system: such as the number of beds and physicians(9,10,28), financing system (18). These factors are also known as supply side variables (10).

Beside mentioned factors, some other variables that have been used in previous studies include: technological changes (9,29), health outcome (10, 14), and environmental factors (30).

In Iran, some studies have investigated the mutual relation between economic growth and health care expenditure (31-33) or the effect of healthcare expenditure on health outcome (34). However, there is a need for a specific study on the determinants of health care expenditure in Iran. Therefore, the current study aims to identify long-term and short-term determinants of health care expenditure in Iran over the period of 1971 to 2007 using the Auto Regressive Distributive Lag (ARDL) bound testing approach.

Materials and Methods

Data and variables

The primary model to be estimated is presented in equation1.

HE = f (E, D, S) equation (1)

Health care expenditure (HE) is a function of economic (E), demographic (D) and supply side or health care system(S) variables. In this study the variable representing the economic factors were limited to income. The variables representing the demographic factors were limited to share of senior population and urbanisation. Finally, the variables representing supply side were limited to physicians' density and bed index. Therefore

$L\,GHE_t = F(L\,GNP_t, P65_t, URB_t, PH_t, BED_t)$ equation (2)

Where, $L\,GHE_t$ shows logarithm of per capita government health care expenditure in periodt. $L\,GNP_t$ is logarithm of per capita gross national product in periodt. Population aged 65 and above as a percentage of the total population in periodt ($P65_t$)is measure of share of senior population. URB_t Shows the share of urban population of total population in periodt. PH_t and BED_t indicate the number of physicians and the number of hospital beds per 1000 persons in period t, respectively.

Like most other studies, the variables of health care expenditure and income have entered the study logarithmically. The reason for this is offering the health care expenditure coefficient in income elasticity of health care expenditure.

The annual time series data from 1971-2007were used to estimate the mentioned model. The data were collected from the official websites of the Iranian Statistics Centre, Central Bank of Iran, and the Ministry of Health. Data related to the population above 65 in the census years, were interpolated to obtain the population of them in other years. Views 7and Microfitsoftware were used to estimate the model and conduct the tests.

Econometric methodology

Unit roots test

In analysis of time series data model, to predict the dependent variable accurately, it is supposed that the data structure does not change over the time; this is known as stationary. So before running the causality test the variables must be tested for stationary. In econometric literature a time series data is stationary when the average, variance and co-variance are constant over the time(35). If non-stationary variables are used in the model, validity of coefficients will be low, relying on t and F tests will not be possible, and problem of spurious regression will be occurred. Therefore, at first we used conventional Augmented Dickey–Fuller (ADF) unit root test to check the stationary condition and the order of integration of the variables.

ADF test was used in two modes: one time with constant value, and the second time with constant value and trend. Null hypothesis of the test was defined as “the variable is non-stationary and has a unit root”.

ARDL Bounds test for co integration

Since most economic variables are non-stationary over the time, in order to avoid spurious regression, co-integration test was used as a preliminary test(36).

In empirical studies, if the non-stationary variables are co-integrated, the long term and short term relationship among variables could be understood and the estimates of regression remain valid. Thus, autoregressive distributed lag(ARDL) bounds approach, developed by Pesaranand Shin, was used(37). The ARDL bound test has some important advantages. First, this approach could be used regardless of whether the model variables are integration order of 0 (I (0)) or 1 (I (1)). In other word, it can be used in the cases where the variables do not have similar order of integration. Second, it can be used in studies with small sample size. Finally, by using this model, the parameters can be estimated in short term, long term and error correction model (ECM).

In this approach, before estimating the long term and short-term coefficients of explanatory variables, it should be ensured that there is long-term relationship between variables of model (co integration relationship).

For analysing the long-term relationship, the error correction model (equation3) was developed and estimated.

$$\Delta(\log GHE)_t=\beta_0+\beta_1(\log GHE)_{t-1}+\beta_2(\log GNP)_{t-1}+\beta_3(P65)_{t-1}+\beta_4(URB)_{t-1}+\beta_5(PH)_{t-1}+\beta_6(BED)_{t-1}$$
$$+\sum_{i=1}^{p}\alpha_i\Delta(\log GHE)_{t-i}+\sum_{i=0}^{p}\mu_i\Delta(GNP)_{t-i}+\sum_{i=0}^{p}\lambda_i\Delta(P65)_{t-i}+\sum_{i=0}^{p}\gamma_i\Delta(URB)_{t-i}+\sum_{i=0}^{p}\theta_i\Delta(PH)_{t-i}+$$
$$\sum_{i=0}^{p}\delta_i\Delta(BED)_{t-i}+\upsilon_t \quad \text{.....(equation3)}$$

Where, Δ is the first-difference and υ_t is a white-noise error term.

For determining the optimal lag length of variables in the model, Schwarz Bayesian Criterion (SBC) was used.

After estimating equation4, the Wald test (F-statistic) was conducted to test the existence of long-run relationship between the variables. The null hypothesis is as follows:

$H_0=\beta_1=\beta_2=\beta_3=\beta_4=\beta_5=0$ (It shows no long run relationship)

The F-statistic value will be compared with the critical values tabulated by Peasant al.(38). According to these studies, the lower and upper bound critical values assumed that the explanatory variables are I (0) and I (1), respectively.

Thus, if the computed F-statistic is above the upper bound value, then the null hypothesis can be rejected, so it could be concluded that there is long-run relationship between health care expenditure and its economic, demographic and supply side determinants. If the computed F-statistic falls below the lower bound value, then the null hypothesis is not rejected. Finally, if the computed F-statistic falls within these two bound values, the results are indecisive and we cannot conclude anything about results of co integration between variables.

Results

The Augmented Dickey-Fuller (ADF) unit root test showed similar results of the order of integration of the variables in both models (with constant value and with constant value and trend): the variables of P65 and BED are integrated of order0 or I(0); while the variables of LGHE, LGNP, URB and PH were stationary with once differentiation or integrated of order1 or I(1) (Table 1 and Table 2). Thus, integration order of variables gave a good justification for use of ARDL bound testing approach.

Table3 shows the results of the bounds co integration test. The computed F-statistic of 6.810 was greater than the upper critical bound value of 4.43, so the null hypothesis (no co integration) is rejected at the 1 percent

significance levelindicating the existence of a long term relationship between the variables.

The long term estimates of the model are shown in Table4.The results showed that in long run GNP has a statistically significant effect (P-value < 0.05) on GHE. The estimated income elasticity of GHE was 0.815, so it indicates that government health care expenditure is not a luxury good.

In short run, the relation between the P65 and GHE estimated to be negative (-1.790) and statistically significant. In addition, PH coefficient was found positive (3.204) and statistically significant. URB and BED variables have no significant effect of the on GHE in short run.

Short-term estimates (Table5) showed statistically significant lower income elasticity ($\beta = 0.577$, P-value < 0.05) compared with long-term estimates. Error correction coefficient is -0.708 and statistically significant. This coefficient shows the correction rate of short-term imbalance towards the long term. Based on the value of the coefficient, about 70 percent of imbalance is corrected in one period. Other explanatory variables were not statistically significant.

According to the F statistic (11.126), the model was entirely significant at 1 percent level. Result of Adjusted R^2 showed that about 60 percent of changes in GHE in Iran can be explained by changes in the independent variables. Durbin Watson statistic was estimated 2.276, which indicate no serial correlation.

Table 1. Results of ADF unit root tests, model with constant

Variables	Level		1st Difference		order of integration
	statistic	P	statistic	P	
LGHE	-1.210	0.659	-5.525	0.0001*	I(1)
LGNP	0.562	0.986	-4.385	0.0014*	I(1)
P65	-3.990	0.004*	-1.547	0.4956	I(0)
URB	-1.063	0.719	-4.943	0.0003*	I(1)
PH	0.901	0.994	-3.313	0.021*	I(1)
BED	-2.874	0.058	-7.076	0.000*	I(0)

*Significant at the 0.05 level

Table 2. Results of ADF unit root tests, model with constant and trend

Variables	Level		1st Difference		order of integration
	statistic	P	statistic	P	
LGHE	- 2.671	0.253	- 5.545	0.000*	I(1)
LGNP	- 1.172	0.900	- 4.230	0.006*	I(1)
P65	- 4.816	0.002*	- 2.321	0.409	I(0)
URB	- 2.839	0.193	- 4.865	0.002*	I(1)
PH	- 0.803	0.955	- 3.856	0.025*	I(1)
BED	- 3.895	0.022*	- 6.930	0.000*	I(0)

*Significant at the 0.05 level

Table 3. Result of Bounds test for the existence of a long-run relationship between variables

Significance level	Critical value	
	Lower Bound Value	Upper Bound Value
1 percent significance level	3.15	4.43
5 percent significance level	2.45	3.61
10 percent significance level	2.12	3.23
F-statistic 6.810*		

*Critical Values are taken from Pesaran et al. (38), Table CI (iii), Case 111: Unrestricted intercept and no trend
**Significant at 0.01 level

Table 4. Long run estimates of health expenditure determinants in IRAN using the ARDL approach

Variable	Coefficient	*t*-statistic	P
LGNP	0.815	2.253	0.033*
P65	- 1.790	- 4.155	0.000*
URB	0.009	0.155	0.878
PH	3.204	3.223	0.004*
BED	0.733	0.871	0.392

*Significant at the 0.05 level

Table 5. Short run estimates of health expenditure determinants in Iran using the ARDL approach

Variable	Coefficient	*t*-statistic	P
DLGNP	0.577	2.351	0.026*
DP65	0.935	1.147	0.261
DURB	0.148	0.910	0.370
DPH	- 0.866	- 0.701	0.489
DBED	0.519	0.863	0.395
ECM(-1)	- 0.708	- 6.237	0.000*
F-statistic	11.126	P	0.000
R^2 (Adjusted)	0.629	DW-statistic	2.276

*Significant at the 0.05 level

Discussion

In current paper, the long term and short term effect of economic, demographic and health system factors on precipitate government health care expenditure and its error correction model were analysed using the Auto Regressive Distributive Lag (ARDL) bound testing approach over the period 1971-2007 in Iran.

Considering the income elasticity of health care expenditure in long and short term (0.815 and 0.577 respectively), the government health care expenditure brought up as a necessity good. Contradictory results have been reported by studies performed in this field. Some studies concluded that the health care expenditure is as a luxury good (39-42) while, some others implied that it is a necessity good (22,43-51).Also, several studies, reported that income elasticity of health care expenditure varies over different methods of estimation, cross sections, and investigated samples(27, 52-54).

The results about income elasticity indicated that GHE is increased more slowly than GNP in Iran. This implies that government should perform more interventions in health care sector. In other words, market mechanisms for providing health care face to some failures (53) in Iran health care system.

In long run, share of the aged population has negative effect on GHE. However It is contrast with findings of most studies in this area (9,10,45), but in some studies insignificant effect was reported (22,55). The most important reason of this contradiction is that most studies have been investigated the actors affecting total health care expenditure, but in present study, determinants of government health care expenditure were analysed. Therefore, we can infer that population aging does not drive government health care expenditure, and maybe more drive private health care expenditure in Iran. Furthermore, it is stated that higher proportion of elderly population, means higher life expectancy and healthy society and it cause lower consumption of health care services and so health care expenditure will decrease (27).

In present study, like many other ones (9,20,28), physician density as a supply side was found as one of the determinants of health care expenditure.

It seems to be the main factor affecting GHE in Iran in long run. This finding shows the theory of physician-induced demand is valid in delivery of health care services in Iran. It is argued that when the density of physicians increases, the demand for services of each of physicians decreases, so they may induce more services with higher prices to their patients (18). It also can be explained by target income hypothesis (56). Furthermore, more supply of physicians can influence utilization by increasing the accessibility to health care services (18). Thereby, physician density leads to higher health care expenditure.

In the short run, only income seems to have an important impact on GHE. This result seems reasonable because in short term, for example one or two years, health sector budget is approximately fixed and is not driven by demographic (P65, URB) or health system (PH, BED) determinants.

The main findings of the present study is that in long run, per capita income, P65,and PH, and in short run income were the most important determinants of government health care expenditure over period 1971-2007 in Iran.

It should be considered that we analysed determinants of government healthcare expenditure, not total health care expenditure, for comparison of our findings with results of other studies.

Regarding the role of health care expenditure in financing of healthcare system and its effect on the society health and on the other hand, the limited government resources and the essence of paying attention to efficiency, it is suggested that the policy-makers and government managers make optimal decisions to establish a balance the health care expenditure.

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Conflicts of interest

The authors declare that they have no conflict of interest.

Authors' contributions

Bayati M and Delavari S designed the research (project concept, development of overall research plan, and study oversights). Ziloochi MH and Delavari S conducted research and gathered required data. Bayati M analyzed data and performed statistical analysis. All authors helped in writing the paper and had primary responsibility for final content. All authors have read and approved the final manuscript.

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