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Forecasting Iran national health expenditures: General model and conceptual framework

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Abstract:

BACKGROUND: Forecasting the future trend of health expenditures is an important step toward sustainable financing of health-care systems. This study aims to develop a conceptual framework for forecasting Iran health spending growth.

MATERIALS AND METHODS: At first, we concentrated on the general model and conceptual framework of health expenditure projection by reference to a broad literature review and smart classifications of the origins of health spending and indicators. At the second step, we developed a time series modeling for econometric estimation and forecasting national health expenditure without restrictive assumptions except for current laws and regulatory environment. In the third step, we tested the accuracy of model by forecasting Iran real per capita health expenditures (2017–2025).

RESULTS: The results of the literature review represented a distinct classification of the origins of health spending and indicators, applicable to any health system and health spending projection model. Furthermore, the model of expenditure forecasting shows the power of certainty of no spurious estimation, assessment of the normal state of a health system, and test of the accuracy of forecasting results. The projection by the Iranian health system database showed that the real per capita health spending will grow 43 percent till 2025 in the absence of any unforeseen disturbance in the future.

CONCLUSIONS: The presented model provides estimates that are compatible with actual trends of health spending and can be applied to forecast health expenditure in the near future. The forecasted image of Iran's health spending growth implies that health authorities need to concentrate more on the growth rate of the health budget and its fiscal space in the near future.

Keywords:

Forecasting, health expenditures, health-care financing

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Introduction

Evidence suggests that the planned and targeted growth of health expenditure improves human capital and raises the productivity of human resources along with the quality of life and social welfare.[1,2] Forecasting the future trend of health expenditures is an important step toward sustainable financing of health-care systems.[1] unsustainable financing arises from the challenging issues in the unexpected rise of health expenditure and lack of control over it, along with increasing interests of the public in unrestricted access to quality health services in the countries.[3,4] In recent decades, developing countries experienced the rapid growth of health expenditures which may root from their reforms and attentions to improve the quality of public health care. However, the unplanned growth of health expenditures can create financial crisis in health care as well as rising poverty and catastrophic health expenditures.[5,6]

In this study, Iran has been considered an example that has many features in common with developing countries with unsustainable financing while pursuing the

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programs to increase access to public health services. The World Bank report on National Health Accounts shows that health expenditure in Iran has risen 4.9 times in nominal values over the past decade, per capita, and the share of total health expenditure (THE) in Iran's Gross National Production has increased from 5.3% in 2002 to 7.1% in 2014.[7] Furthermore, in these years, in Iran, the price index of health services, which is always above the Consumer Price Index (CPI) for all goods and services, has doubled. The statistics of the Iranian Central Bank shows that the price index of health goods and services has grown in an instable and unbalanced state. In 2015 and 2016, the inflation rates of health goods and services were 23.8% and 16.7%, respectively, while the inflation rates of CPI in these years were 11.9% and 9%, respectively.[8] Instability of financial resources as well as inadequate health financing sources has been always considered as the challenging issues for policymakers in Iran.[9,10] Scholars believe that with the current trend of growing health expenditure, the Iranian health system will face serious problems to provide sustainable and adequate funding sources for health services in the future.[11]

There is a complex set of effective factors that make health financing failure worse in the future, including aging, urbanization, changes in the disease pattern, the growing expectations of health-care users, and the growth of health technologies.[3] These issues have made the policymakers seeking the models to understand the future path of health expenditure and identify reform effects to control future pressure from health expenditure rising. This concern has drawn policymakers' attention to try to forecast the health expenditure. Forecasting by the models representing the current trend of health expenditure is a prerequisite for controlling and managing health-care costs as well as planning the future path of health expenditure.

This study aimed to introduce a general model of health expenditure estimation and a universal conceptual framework for its projection accompanied with a presentation concerning Iran national health expenditures estimates during 2017–2025.

Materials and Methods

Study design and setting

This study presents a general time series model to estimate the national health spending and forecast the future path of health spending, using a universal conceptual framework applicable to all health systems. The study design and setting were according to the following steps:

Identification of the total health expenditure determinants

This study identified the determinants of THE, using a broad review of literature in scientific databases including Scopus, PubMed, and Web of Science.[12] This review presented a detailed and comprehensive identification of the variables influencing health expenditure in the long run with reliable sources of forecasting. The search strategy was including the combinations of the following keywords: cost, charge, spending, expenditure, health, health care, health services, factors, effective services, affecting, determinants, predictors, and forecasts. Literature review identified 19 indicators affecting THE growth [Table 1], which are the well-known ones in the considered articles. These indicators provided the opportunity to examine the impacts of a wide range of variables in the forecasting model of health expenditure.

Selection of regression models for forecasting total health expenditure

This study takes advantage of vector autoregressive regression (VAR) and ordinary least squares (OLS) regression models to develop a general forecasting model, using time series data for all variables in the database. The estimation processes were carried out by first-differenced variables to avoid nonstationary data, which is a common problem in time series regressions.[16] The differenced variables were examined on the Dickey–Fuller unit-root test to ensure no spurious estimates. During estimation processes, the determinants of changes in per capita health expenditure were examined for inclusion, using the stepwise method to reach the final regressions with statistically significant variables in the estimation results. The models were also examined for the autocorrelation problem, using the LM and Durbin–Watson tests in Stata14 software (StataCorp. 2015, College Station, Texas, USA). These models and estimation processes were viewed as consistent with the expected results of forecasting, using relevant databases in a health system.

Checking the accuracy of projections

The estimation results of the VAR and OLS models were examined for accuracy, using them before forecasting. This process required applying the data from the years 1971–2011 in the two models to provide forecasts for the years 2012–2016 and comparing these forecasts with the actual values in those years. Then, the model with the estimation results that had the least root of mean squared error (RMSE) was selected to forecast values of the future years, 2017–2025.

Study participants and sampling

In the literature review, 578 articles were identified by advance search at three main databases including Scopus, PubMed, and Web of Science. The search was done without any limitation at publish time and location of articles. Among 578 initial articles, 317 articles were excluded due to the duplication in the databases. Finally, 36 articles had inclusion criteria and were considered

Table 1: The origins, indicators, and variables determining the growth

Origins of health spending	Indicators	Variables
Demographic trend	Population aging[4,13-32]	The proportion of population 65 and over
	Youth population[16,19,23,29,33]	The proportion of population under 15
	Urbanization[3,20,23,25,32,34]	The proportion of population living in urban areas
	Education[3,32]	The rate of literacy
	The last years of life[18]	Number of deaths in a year
Economic conditions	Economic growth[1,3,4,15-20,22,23,25-31,33,35-42]	The economic growth rate
	Average income level[13,14,21,24,32,34,43,44]	Per capita income/real GNP
	Income inequality[42]	Gini coefficient
	Unemployment[33]	The rate of unemployment
Technological capabilities	Health technology growth[4,13-15,18,19,22,26,33,36,41,44]	Time trend
		Imaging centers per 1000 population
		Infant mortality rate
		Life expectancy at birth
Health services delivery environment	Change of life style[22,24,32]	Share of beverages, fast foods, and smoking in household food basket
	Quality of environment[27]	Per capita CO_2 emission
	Occurrence of war and rebellions[42]	Quality indicator for years of war
Health demand forces	Growth of noncommunicable and chronic diseases[40,45]	BMI growth
Health supply forces	Access to services of providers[3,13,14,16,17,23,24,27,32-34,37]	Physicians per 1000 population
	Access to inpatient services[13,14,25,32]	Hospital beds per 1000 population
Health system management potencies	Share of government in health system financing[16,20,22,26,29,30,35]	Share of government in health system financing
	Unbalanced growth of providers salaries[18,39,40]	Baumol variable*
	Health insurance development[17,32,40]	Share of social health insurance in health system financing

*Baumol variable implies that the slow growth of health-care productivity coupled with a rapid rise in wages is due to the high growth of productivity in the leading industries. BMI=Body mass index, GNP=Gross national production

for content analysis. The inclusion criteria were the originality of the researches and the identification of the determinants of THE at the national level. Therefore, articles that had focused on out-of-pocket payments, private health expenditure, and costs of illnesses had not been considered. At the second part of the study, the THE of the Islamic Republic of Iran was the subject of the study which was completely considered without any sampling.

Data collection tool and technique

This study developed a database for the determinants of health expenditures in Iran health system. This database consists of 24 variables within 46 years, 1971–2016. We collected these data by direct refer to Iran's National Institute for Health Research (NIHR), Iranian Statistical Center, Central Bank, and other public sector organizations. The database is available in the NIHR. Creating such a database can be viewed as another step in the project of health expenditure forecasting in developed and developing countries, regarding the need for updating forecasts in the future.

Ethical consideration

This study was supported by I.R. Iran's NIHR (approved no: 241/M/96105). The Ethics Committee of the Iranian NIHR approved this study (approved no: IR.TUMS.NIHR.REC.1396.31).

Results

Current trend of real per capita health expenditure

Understanding the time path of real per capita health spending is crucial before examining further changes over time. This issue is shown in Figure 1 by a time trend quadratic polynomial function. In this figure, the real per capita health expenditure for the Iranian database at constant price indices of 2016 has an ordinary shape over the long run, indicating an increase of more than six-fold, from 2 to 12.3 million Iranian Rial in the years from 1971 to 2016. In this trend model, the estimates exclude the impacts of inflation and population growth from the growth figures. Hence, the result can be consistent with an ordinary path of growth forecasting.

Estimation of vector autoregressive regression and ordinary least squares models and accuracy of their projections

Table 2 shows the estimation results of the two regression models for the growth of real per capita health expenditure in the period 1971–2011. The estimations with the Iranian database showed that the VAR model provided the results, which are accounting for 70%

Table 2: Estimation regression models for health expenditures

VAR model for estimation the growth of real per capita health expenditures					
Explanatory variables	**Lag**	**Coefficients**	**SE**	***Z*-statistics**	***P***
Growth of real per capita health expenditures	t-1	0.5463139	0.0930022	5.87	0.000
Growth of mortality rate	t-1	−0.0115345	0.0059521	−1.94	0.053
Growth of the share of fast foods and cigarettes in household consumption basket	t-1	0.2987621	0.1143081	2.61	0.009
Growth of CO_2 emission	t-1	0.5422141	0.1237559	4.38	0.000
Bumble variable	t-1	0.0200124	0.0104159	1.92	0.055
R^2=0.6994					
OLS model for estimation the growth of real per capita health expenditures					
Explanatory variables	**Lag**	**Coefficients**	**SE**	***T*-statistics**	***P***
Growth of real per capita health expenditures	t-1	0.3301263	0.1101574	3.00	0.006
Growth of urbanization	t	−14.11474	5.716454	−2.47	0.020
Gini coefficient of income inequality	t	2.303141	0.4410846	5.22	0.000
Unemployment rate	t	0.0117369	0.0068286	1.72	0.097
Growth of life expectancy at birth	t	−3.712194	1.170728	−3.17	0.004
Growth of body mass index	t	58.32762	20.77053	2.81	0.009
Dummy variable for years of Iran-Iraq war	t	−0.0621278	0.0320944	−1.94	0.063
Growth of physicians per population	t	0.3308871	0.1652049	2.00	0.055
Hospital beds per population	t	−0.463992	0.122797	−3.78	0.001
Share of government in health system financing	t	−0.4936342	0.1906006	−2.59	0.015
Baumol variable	t	−0.0291306	0.0092888	−3.14	0.004
Share of social health insurance in health system financing	t	−0.9179994	0.417963	−2.20	0.037

R^2=0.8580. SE=Standard error, VAR=Vector autoregressive regression, OLS=Ordinary least squares

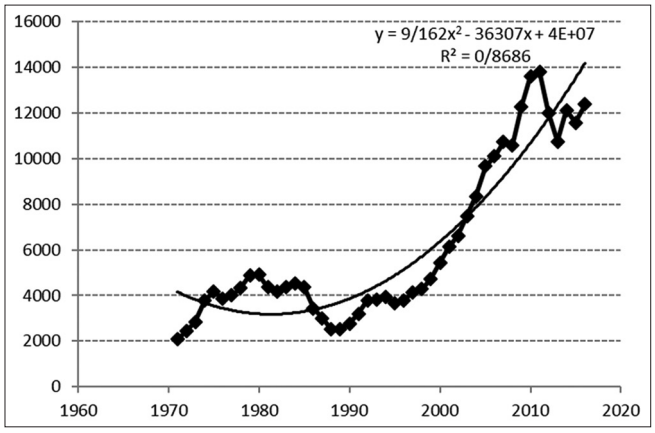

Figure 1: Current trend of per capita real health expenditures in Iran

of changes in the growth of real per capita health expenditure, on average. In this model, in addition to the lagged value of the dependent variable, there are four other explanatory variables with statistically significant coefficients. On the other hand, the estimation of the OLS model gave rise to the results, which are accounting for 85.8% of changes in the growth of real per capita health expenditure on average. In this model, in addition to the lagged value of the dependent variable, there are 11 explanatory variables with statistically significant coefficients. At first glance, both models are qualified to be used for forecast estimation.

Having the results of estimates of the above two models and the outcomes for the years 1991–2011, we compare the forecasts of these two models for the growth of real per capita health expenditure for the years 2012–2016. This comparison, shown in Table 3, indicates that the RMSE in absolute value in the VAR model is less than the RMSE in the OLS model. Furthermore, the annual deviations of the forecasts from the real values in the VAR model are between 0.2% and 14.9%, and the same forecast deviations in the OLS model are between – 42.3% and – 24.3%. These results indicate that the VAR model with lower RMSE and lower forecast deviations is the more reliable model for forecasting the growth of real per capita health expenditure in the future, the years 2017–2025.

Forecast results of real per capita health expenditures in 2017–2025

Using the estimates of the VAR model in the years 1971–2016, the future trend of real per capita health expenditure for the years 2017–2025 has been forecasted. Table 4 shows the forecast results of the VAR model. The forecasts do not take into account any likely shock or instability in the coming years. In the above forecasts, the recommended forecast error in the years 2017–2025 is about ±10%. Table 4 also shows the lower and upper forecast estimates of real per capita health spending.

Discussion

Health authorities need to develop their knowledge about the trend of the health expenditure and the details of the origins of health spending and indicators that explain the growth of health services and expenses to forecast and control the upward spending trend of these

Table 3: Comparison of the deviation of the forecast values from the actual values in 2012-2016

Model	Year	The growth of real per capita health expenditure		Real per capita health expenditure		Error of forecasting		RMSE
		Predicted	Actual	Predicted (IR)	Actual (IR)	Absolute error (IR)	Relative error (%)	
VAR model	2012	−0.004564	−0.130462	13,751,803	12,012,545	1,739,258	14.5	1452914
	2013	−0.065589	−0.105678	12,849,838	10,743,085	2,106,754	19.6	
	2014	−0.055519	0.127705	12,136,427	12,115,033	21,394	0.2	
	2015	0.096217	−0.044414	13,304.,155	11,576,962	1,727,193	14.9	
	2016	−0.044252	0.069989	12,715,415	12,387,225	328,190	2.6	
	Mean	−0.014742	−0.016572	12,951,528	11,766,970	1,184,558	10.4	
OLS model	2012	0.0241229	−0.130462	14,148,112	12,012,545	2,135,567	17.8	2997892
	2013	−0.0558925	−0.105678	13,357,339	10,743,085	2,614,255	24.3	
	2014	−0.1780581	0.127705	10,978,957	12,115,033	−1,136,076	−9.4	
	2015	−0.1447664	−0.044414	9,389,573	11,576,962	−2,187,389	−18.9	
	2016	−0.2389027	0.069989	7,146,379	12,387,225	−5,240,846	−42.3	
	Mean	−0.118699348	−0.016572	11,004,072	11,766,970	−762,898	−5.7	

VAR=Vector autoregressive regression, OLS=Ordinary least squares, IR=Iranian Rial, RMSE=Root of mean squared error

Table 4: Real per capita health expenditures with the Iranian database in the years 2017-2025

Year	The growth of real per capita health expenditure (%)	Real per capita health expenditure (IR)	Estimation CI	
			Lower limit (IR)	Upper limit (IR)
2017	6.33	13,171,179	11,854,061	14,488.297
2018	4.59	13,775,962	12,398,366	15,153,558
2019	4.52	14,399,081	12,959,173	1,5838,989
2020	4.53	15,051,726	13,546,553	16,556,898
2021	4.56	15,738,333	1,164,499	17,312,166
2022	4.59	16,461,191	14,815,072	18,107,310
2023	4.62	17,221.855	15,499,669	18,944,040
2024	4.64	18,021,553	16,219,398	19,823,709
2025	4.66	18,861,277	16,975,149	20,747,404

IR=Iranian Rial, CI=Confidence interval

services in the future. The projection of national health expenditures (NHEs) based on a time series database can provide the proposed sources for health-care planners and policymakers. This study has provided a general model for projection of the future path of NHE, with a conceptual framework concerning the determinants of health spending and indicators. This result arose from an in-depth understanding of the literature in the field and a smart classification of sources of health spending and indicators. Furthermore, the general models and variables, defined with accurate specifications, are adapted to any database for a health system. The estimation method presents the three stages of searching the trend of the dependent variable with general characteristics over time, reviewing the initial forecasts of alternative estimation models to compare precision measurements, and displaying the forecast results. The VAR and OLS regression models have variables with no problem of spurious estimation results. The above characteristics of the model of health spending projection were examined in detail with a presentation concerning estimates with the Iranian health system database. This model can also be employed to forecast health spending with any database in developed and developing countries.

The results for Iran imply that in 9 years in the future, beginning from 2017, the real per capita health spending will grow at the average annual rate of 4.78% and a total of 43% in 2017–2025, disregarding any unexpected disturbance in the future. Adding the past 10 years' average growth rate of population, equal to 1.4%, the average growth rate of NHE in real terms will be 6.18% annually and a total of 55.62% in 9 years in the future. The average inflation rate of health expenditure from the past 10 years was 12%. Adding this inflation rate to the above real growth rates implies that we should expect much higher growth rates of per capita and total NHE in nominal terms in the future. This result makes households spending on health services much worse when the budget constraint of the government limits the annual growth of the health budget in the future. This image of health spending in the coming years implies that health authorities need to concentrate on the growth rate of the health budget and simultaneously on health spending of the public with the lowest rise.

The results of this study compared with the recently published report of the Central Bank of Iran (CBI)[46] on health-care overview and forecast in Iran. The figures in the CBI report are the overall values in the nominal

term, referring to 2 years, 2014 and 2019. In that report, the source and method of forecasts for 2019 remain unknown, and some may assess the results as optimistic and some others pessimistic. Furthermore, Ramezanian *et al*.[47] have used the autoregressive integrated moving average (ARIMA) forecasting model to project the health figure of 2020 in Iran. The results showed that the total health spending by government and households will increase 75% during the years 2016–2020. This overestimation arises from the estimation nature of the ARIMA model that ignores the analytical characteristics of the growth process.

Keehan *et al*.[48] used mixed actuarial and econometric methods with some presumptions about future trends to forecast the growth of national health spending in the United States during 2018–2027. In that study, the economic and demographic assumptions and the current laws of health insurance plans and coverage were the principal issues in modeling the health expenditure projection. In that projection, the details of the growth of health insurance enrollees and per enrollee expenses in the subsections of private health insurance, Medicare, and Medicaid were the sources of data for obtaining the THE. The authors argued that the forecasts are subject to some uncertainties, which are related to multiple factors and assumptions; some of them arise from changes in economic conditions and legislation, providers' responses to such changes, and consumers' behavior on payments for health insurance premiums and copayments. That study has provided a long list of correlated forecasts, and hence, there are many uncertainties in the final results. In general, that study and many other similar studies on health spending projection take into account several factors that are considered the drivers of the growth in personal health spending during the forecast period. Those studies differ in the factors affecting health expending, econometric modeling, assumptions, projection outputs, and the impact of uncertainty on forecasting.

In this study, differently, the sources of health spending are taken from a comprehensive review of literature, and econometric models are specified with the least limiting assumptions and uncertainties in the forecasts except for changes in the regulatory environment and economic conditions. Furthermore, in this study, the general model provides the results that are compatible with any health system database and consistent with the actual trends of health spending in the absence of unexpected disturbances in the future.

Limitations and recommendation

The present study had an important limitation that should be considered in the application of the results. The presented forecasts of the THE growth are based on the assumption of the continuation in the current situation and the absence of any unexpected economic, social, and political shocks. Any uncommon impact on Iran health-care market (such as war and epidemic) will lead to deviation of THE from the predicted values. Therefore, maintaining the existing trend should be considered in the use of results. It should be suggest for the future studies to consider the effect of COVID-19 outbreak - which was not predicted at the time running this study- on THE growth rate. Furthermore, it is recommended for future studies to expand our forecasts by focusing on the error correction modes.

Conclusions

The presented model provides estimates that are compatible with actual trends of health spending and can be applied to forecast health expenditure growth in the near future. The forecasted image of Iran's health spending growth implies that health authorities need to concentrate more on the growth rate of the health budget and its fiscal space in the near future.

Acknowledgment and ethical moral code

This study was supported by I.R. Iran's NIHR, and the Ethics Committee of the NIHR approved this study (approved no: IR.TUMS.NIHR.REC.1396.31). We would like to dedicate our great thanks to all managers and staffs of NIHR for their kind participation and companionship.

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Conflicts of interest

There are no conflicts of interest.

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