Original Article
http://mjiri.iums.ac.ir
Medical Journal of the Islamic Republic of Iran (MJIRI)

Med J Islam Repub Iran. 2019(1 Apr);33.25. https://doi.org/10.34171/mjiri.33.25

Forecasting health expenditures in Iran using the ARIMA model (2016-2020)

Maryam Ramezanian[1], Ali Akbar Haghdoost[2], Mohammad Hossein Mehrolhassani[3], Masoud Abolhallaje[4], Reza Dehnavieh[5], Behzad Najafi[6], Ali Akbar Fazaeli*[7]

Received: 8 May 2018 Published: 1 Apr 2019

Abstract

Background: Accurate economic forecast has important effects on governmental policy and economic planning, and it can help policymakers to make decisions for future and create new infrastructures for the development of new forecasting methods. This study calculated total health expenditure, public health expenditure and out of pocket (OOP) payment for 2016-2020.

Methods: Autoregressive Integrated Moving Average Process (ARIMA) is one of the most important forecasting models. In this study, five-year values were forecasted using EViews8 software according to health expenditures in Iran from 1971 to 2015.

Results: Applying annual data for total health expenditure, resulted in the ARIMA (1,1,1) model being the most appropriate to predict these costs. The results of this study indicate that total health expenditures will reach from about 1228338 billion IRR in 2016 to 2698346 billion IRR in 2020 and the amount of out of pocket (OOP) will become more than 41% of total health expenditure in 2020.

Conclusion: Total health expenditures in 2020 will become more than two halves in 2016. These expenditures indicated there is a need for continued governmental support of this sector during the upcoming years.

Keywords: ARIMA model, Health expenditures, OOP, Forecast

Conflicts of Interest: *None declared*
Funding: *Iran Ministry of Health and Medical Education and the Institute for Future Studies in Health of Kerman University of Medical Sciences*

Cite this article as: Ramezanian M, Haghdoost AA, Mehrolhassani MH, Abolhallaje M, Dehnavieh R, Najafi B, Fazaeli AA. Forecasting health expenditures in Iran using the ARIMA model (2016-2020). *Med J Islam Repub Iran. 2019* (1 Apr);33:25. https://doi.org/10.34171/mjiri.33.25

Introduction

In recent decades, increased health care expenditure has made some problems for financing health expenditures in the society, so that provision of household health expenditure by the government is considered as an important challenge in the health system (1, 2). Forecast of the trend of variables is one of the important issues in economic studies. A correct forecast has an important effect on governmental policy and planning and it can help policymakers in making future planning and provide infrastructure for the development of new ways of forecasting (3). According to definitions, prediction of future situations and events is called forecast. Forecaster prepares a generalized model for the future, according to obtained information from past and analysis of this data.

Corresponding author: *Dr Ali Akbar Fazaeli, afazaeli83@gmail.com*

1. Research Center for Health Services Management, Institute for Futures Studies in Health, Kerman University of Medical Sciences, Kerman, Iran
2. Modeling in Health Research Center, Institute for Future Studies in Health, Kerman University of Medical Sciences, Kerman, Iran
3. Social Determinants of Health Research Center, Institute for Futures Studies in Health, Kerman University of Medical Sciences, Kerman, Iran
4. Ministry of Health & Medical Education, Tehran, Iran
5. Health Services Management Research Center, Institute for Future Studies in Health, Kerman University of Medical Sciences, Kerman, Iran
6. Tabriz Health Services Management Research Center, Health Management and Safety Promotion Research Institute, Tabriz University of Medical Sciences, Tabriz, Iran
7. Department of Health management and economic, School of Public Health and Research Center for Health Sciences, Hamadan university of Medical Sciences, Hamadan, Iran

↑What is "already known" in this topic:
Health financing is an important subject in recent decades. Forecasting healthcare expenditure is a robust way to know what happens in the next years.

→What this article adds:
This study forecasted three health expenditure trend (public, out of pocket and total) for 2016-2020 and was the first study in this field in Iran. The results of this study indicate that total health expenditure in 2020 will become more than two halves in 2016.

This basic method is used in most forecasting methods assuming the continuation of obtaining a model in the future. Econometric models are tools which are used by economists to forecast future economic changes. In the simplest word, econometricians measure past relationships between variables such as consumption expenditure, household income, tax rates, interest rates, and employment, and then try to forecast how changes in some variables might affect the future path of others. Econometricians generally begin their work with an economic model to be able to do such calculations. This model is a theory about the interaction between various factors in the economy (4). This study uses Box–Jenkins forecast method to forecast five-year health expenditures from 2016 to 2020 through health information of four recent decades. Fair finance of health system is one of the most important health issues, as the World Health Organization emphasized the importance of this issue in 2000 and the way of achieving fair financing methods in the report of 2010 (5). Most countries aim to ensure public fair participation in health expenditures (6). Total health expenditures (THE) include public expenditure of health sector (THE) and individual expenditure in this sector (OOP & private health expenditures). It is necessary to reduce public share in health expenditure by increasing share of government and insurance companies (public sector) in this field. High share of households' direct payment from total health expenditure increases the risk of household exposure to catastrophic health expenditures (7, 8). One of the main tasks of governments is to protect households' financial against health payments and expenditures (9). Therefore, reduction of out of pocket (OOP) payment is one of the policies of the health sector in Iran as mentioned in the fourth, fifth and sixth development plans (10). This is a descriptive study that simulates the trend of the past and suggests that if this trend continues, what happens in the next years.

Methods

ARIMA model (p, I, q)

The development and construction of ARIMA models as forecasting tools of economic variable values are known as the Box–Jenkins method (11). This model is one of the most popular linear models for forecasting time series, which has useful applications in the economic forecast. ARIMA model consists of autoregressive (AR) and moving average (MA) models obtained by differentiating dependent variable due to its durability. Components of this model are then explained (12). The autoregressive vector model is a statistical model which expresses linear dependence between several time series. Autoregressive model estimates future of time series using its past and other series at several time lags (13). AR model with p order is as follows:

$$y = c + \sum_{i=1}^{p} \alpha y_{t-1} + \varepsilon \qquad \text{(I)}$$

Where, q represents parameter of model, C is a model constant, and ε is an error term. Moving average model with q order is defined as follows (14).

$$y = \mu + \varepsilon_t + \sum_{i=1}^{q} \theta_i y \varepsilon_{t-1} \qquad \text{(II)}$$

The Autoregressive Moving Average Process (ARMA), which is sometimes called the Box–Jenkins forecast method, is a model that is commonly used to measure time-series data. ARMA model is a tool for examining and forecasting future values in time-series data . This model consists of two sections, AR and MA. Therefore, the ARMA model is represented as ARMA (p, q) in the scientific literature, where p is the order of the AR model, and q is the order of the MA model (15).

$$y = c + \sum_{i=1}^{p} \alpha y_{t-1} + \varepsilon_t + \sum_{i=1}^{q} \theta_i y \varepsilon_{t-1} \qquad \text{(III)}$$

It will be changed to the ARIMA model considering differentiation of variable as a dependent variable due to non-durability of variables:

$$\Delta y = c + \sum_{i=1}^{p} \alpha y_{t-1} + \varepsilon_t + \sum_{i=1}^{q} \theta_i y \varepsilon_{t-1} \qquad \text{(IIII)}$$

Augmented Dickey-Fuller test (ADF) can be used to test the durability of variables. Numbers of autoregressive and moving average terms is usually calculated using self-correlation functions (16), but since there may be other optimal models, which are preferred to the above-mentioned model, these models are reviewed by Akaike or Schwarz criterion, so that a model is suitable if it has the lowest Akaike or Schwarz value (17) .

Data analysis

Applied data of this study consisted of total health expenditure, public health expenditures, and the Iranian households' out of pocket (OOP) payment from 1971 to 2015. This data was based on data of national health accounts from 2002 to 2015 as well as data of Budget and Performance Monitoring Center of Iran Ministry of Health and Medical Education from 1971 to 2001. Figure 1 shows amounts of these expenditures since 1996. As shown, the total health expenditure was more than 45000 billion IRR in 2002, and it reached more than 1035000 billion IRR with an accelerated trend in 2015. (18)

Given the fact that this study is a retrospective study, in the cost's forecasts, factors such as inflation and the conditions of recession and economic prosperity in the

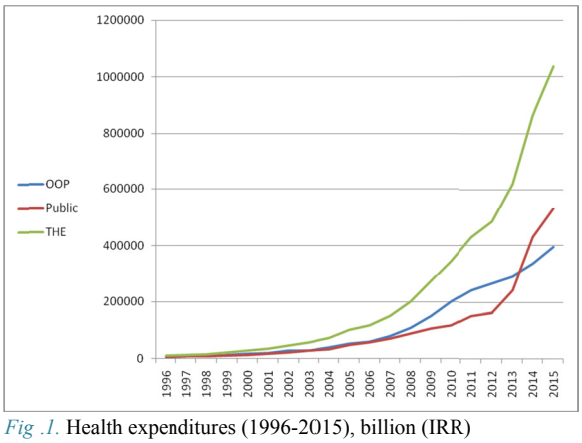

Fig .1. Health expenditures (1996-2015), billion (IRR)

coming years can affect the results of this study. For (PHE), public health costs include government fees and insurance.

Model estimation

We first build natural logarithm of LTHE, LPHE, and LOOP series by converting (THE), (PHE) and (OOP) time series, and then approve unit root and instability of time series by examining the process and the ACF function as well as ADF test(2). According to Table 1, given that statistic of the first and second legs of the series are less than the critical values, this series has a unit root with an error probability of 5%, and it is also determined that the series becomes static by a differentiation. Using the Akaike information criterion (AIC), we provide a criterion for determining the optimal lags of the model.

Results

Using autoregressive econometric models of ARIMA (1,1,1) for (OOP), ARIMA (1,1,4) for public health expenditures, and ARIMA (1,1,4) for total health expenditures from a 45-year-old sample, we forecasted in five years out of period. For more accurate estimates, we used logarithmic values of variables and again converted forecasted values into natural numbers. Selection of these p and q degrees for the model was done by frequent estimates and consideration of significance level and Akaike and Schwarz Criteria. Table 1 shows a stability test of variables. Values of Augmented Dickey–Fuller test (ADF) indicate that tree time series are non-stationary and have a unit root over time, and their estimation will result in false regression. Therefore, we have to differentiate and stabilize them, and then estimate the model. Table 2 also shows, model estimation based on various lags. Forecasts of total health expenditures, out of pocket (OOP) payment, and public governmental expenditures are also presented in Table 3.

The sum of (OOP) and (PHE), (THE), is NOT due to the fact that complementary insurance also exists as private insurance in the country that receives prepayment from people and their value is less than 10% of (THE).

Table 1. Non-Stationary tests

	Probability
ADF (LOOP)	0.94
ADF (LPHE)	0.98
ADF (LTHE)	0.96

Table 2. Model estimation

Dependent Variable: D (LOOP)

Variable	Coefficient	Probability
AR(1)	-0.79	0.0000
MA(1)	0.98	0.0000

Dependent Variable: D (LPHE)

Variable	Coefficient	Probability
AR(1)	0.36	0.0202
MA(4)	-0.37	0.0184

Dependent Variable: D (LTHE)

Variable	Coefficient	Probability
AR(1)	0.54	0.0007
MA(4)	-0.34	0.0448

Discussion

This study forecasted three health expenditures (public, out of pocket payment and total) for 2016-2020. As shown in Figure 1, it is noteworthy that the out of pocket (OOP) payment was more than public health expenditures by 2014 (implementation of the health system development plan) ,but these two variables were replaced in the same year. Since 2014, The distance between (OOP) and (THE) has grown with less growth. In the years prior to 2014, the government's share and insurers in financing the health system was less than 50%, and the share of people more than 50%. However, since then, the health sector's budget has seen significant growth. Of course, the total amount of (PHE) and (OOP) is not equal to the (THE), as there are private health costs, including complementary insurance, and this study is based on the assumption that this insurance has a steady share of this market.

This research was the first study in this field in Iran despite similar studies by Gutzan (2000) for forecasting health expenditures (19). Zhaw also forecasted China's health expenditures in 2010 (20). Results of this study indicate that total health expenditures will reach from about 1228338 billion IRR in 2016 to 2698346 billion IRR in 2020. Considering this growth of 193 percent during the sixth development plan years, out of pocket (OOP) payment will rise from 462104 billion IRR to 1121190 billion IRR, and public sector payment will rise from 657766 billion IRR in 2016 to 1456827 billion IRR in 2020. Out of pocket payment percentage will also be about 41% in 2020. One of the challenges faced by governments is the reduction of out-of-pocket payments through providing subsidies (21). Despite the reduction of this number in this year, it is still far from the goals of Iran's development plans which have considered a share of 30% for out of pocket payment (22). Private health expenditures such as complementary insurance are different between (THE) & total (PHE & OOP). However, comparison of this figure with the 2000s (share of out of pocket payment was 59% in 2010 (5)) indicates a decrease of more than 20%.

Table 3. Model estimation for forecast, million (IRR)

Year	Total Health Expenditures*	Out of pocket	Government Health Expenditures (government & insurance)	OOP%
2016	1228338992	462104668	657766828	37.6
2017	1435813410	551788679	752122064	38.4
2018	1703728707	679549898	888604977	39.9
2019	2108178425	859926206	1122600812	40.8
2020	2698346031	1121190404	1456827621	41.6

* Complementary insurance as private insurance are not mention in table (3)

Conclusion

This study shows that the amount of out of pocket (OOP) payment will become more than 41% of total health expenditure in 2020, and it indicates a gap between goals of development plans and perspective document which indicate less than 30% of share. Given the characteristics of the health sector, such as market failure and generality of this commodity as well as upstream laws, there is a need for governmental and public intervention and continued governmental support of this sector during the upcoming years. It should be noted that this estimate is according to the past trend of health expenditure time series, so that recent years had a greater impact on forecasting; hence, the governmental policies have affected higher payment for health sector in 2014 and 2015 such as implementation of health system development plan, allocation of one percent of Value Added Tax (VAT) to the health sector, and the allocation of 10% of subsidy reform plan resources to the health sector in order to achieve the above-mentioned values; and any change in this policy will surely change this forecast. If this trend continues, increasing health costs will be problematic. Especially if the government and insurance are to provide more of these costs, there is a need for new sources to sustain these costs.

Acknowledgments

We would like to show our gratitude to the Budget and Performance Monitoring Center of Iran Ministry of Health and Medical Education and the Institute for Future Studies in Health of Kerman University of Medical Sciences .

Conflict of Interests

The authors declare that they have no competing interests.

References

1. Ghiasvand H, Olyaeemanesh A, Majdzadeh R, Abdi Z, Mobinizadeh M. Has the Financial Protection Been Materialized in Iranian Health System? Analyzing Household Income and Expenditure Survey 2003-2014. JRHS 2018;18(1).
2. Fazaeli AA, Ghaderi H, Salehi M, Fazaeli AR. Health care expenditure and GDP in oil exporting countries: evidence from OPEC data, 1995-2012. Global J Health Sci. 2016;8(2):93.
3. Chaabouni S AC. Modelling and forecasting of Tunisia's health expenditures using artificial neural network and ARDL models. Int J Med Sci Public Health. 2013;1(2):495-503.
4. Klazoglou P, Dritsakis N, editors. Modeling and Forecasting of US Health Expenditures Using ARIMA Models. International Conference on Applied Economics; 2017: Springer.
5. Moghaddam AV, Damari B, Alikhani S, Salarianzedeh M, Rostamigooran N, Delavari A, et al. Health in the 5th 5-years Development Plan of Iran: main challenges, general policies and strategies. Iran J Public Health. 2013;42(Supple1):42.
6. Pan Y, Zhang M, Chen Z, Zhou M, Zhang Z, editors. An ARIMA based model for forecasting the patient number of epidemic disease. Service Systems and Service Management (ICSSSM), 2016 13th International Conference on; 2016: IEEE.
7. Sakha MA, Rashidian A, Bazyar M, Sari AA, Yazdani S, Moghadam AV. Health financing assessment and policy analysis toward universal health coverage: a systematic review of qualitative research. Global J Health Sci. 2017;9(5):131-42.
8. Fazaeli AA, Fazaeli AA, Hamidi Y, Moeini B, Valinejadi A. Analysis of iranian household financial participation in the health system: Decomposition of the concentration index approach. Koomesh. 2018;20(2):358-65.
9. Rezapour A, Azar FE, Aghdash SA, Tanoomand A, Shokouh SM, Yousefzadeh N, Manesh PA, Asiabar AS. Measuring equity in household's health care payments (Tehran-Iran 2013): technical points for health policy decision makers. Med J Islam Repub Iran 2015;29:246.
10. Aeenparast A, Rezaie Ym, Zandian H, Haeri AA. Catastrophic health expenditures in iran: a review of the literature. Payesh. 2016;15(1):7-17.
11. Chauhan A, Singh A. An ARIMA model for the forecasting of healthcare waste generation in the Garhwal region of Uttarakhand, India. International Journal of Services Operations and Informatics. 2017;8(4):352-66.
12. Getzen TE. Measuring and forecasting global health expenditures. World Scientific Handbook of Global Health Economics and Public Policy: Volume 1: The Economics of Health and Health Systems: World Scientific; 2016. p. 177-215.
13. Bakar NA, Rosbi S. Data Clustering using Autoregressive Integrated Moving Average (ARIMA) model for Islamic Country Currency: An Econometrics method for Islamic Financial Engineering. 2017.
14. Montgomery DC, Jennings CL ,Kulahci M. Introduction to time series analysis and forecasting: John Wiley & Sons; 2015.
15. Sen J, Chaudhuri TD. A Time Series Analysis-Based Forecasting Framework for the Indian Healthcare Sector. 2017.
16. González JRH. Unit Root Testing in ARMA Models: A Likelihood Ratio Approach. 2016.
17. Brockwell PJ, Davis RA. Introduction to time series and forecasting: springer; 2016.
18. Bastani P, Abolhalaj M, Molania Jelodar H, Ramezanian M. Role of Accrual Accounting in Report Transparency and Accountability Promotion in Iranian Public Health Sector. Middle-East Journal of Scientific Research. 2012;12(8):1097-101.
19. Getzen T. Forecasting health expenditures: short, medium and long (long) term. 2000.
20. De-lin L. Annual Precipitation Forecasting of Zhengzhou City Based on ARIMA Model [J]. Research of Soil and Water Conservation. 2011;6:053.
21. Hamidi, Y, Barati, M. Communication skills of heads of departments: Verbal, listening, andfeedback skills. J Res Health Sci. 2011;11(22):91-96.
22. Aboutorabi A, Ghiasipour M, Rezapour A, Pourreza A, Asiabar AS, Tanoomand A. Factors affecting the informal payments in public and teaching hospitals. Med J Islam Repub Iran. 2016;30:315.