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Investigating Interactions among Health Care Indicators, Income Inequality and Economic Growth: A Case Study of Iran

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Abstract

Life expectancy and infant mortality are two major indicators for assessing the efficiency of every social health system. The bulk of literature on health economics is related to unilateral influences of macroeconomic variables on health sector indices and less attention has been paid to bilateral and simultaneous effects. Therefore, this paper aims to examine the bilateral and simultaneous impacts of the key macroeconomic variables on life expectancy and infant mortality in Iran during 1981-2018. To this end, by considering the ..... . mett ’ aaalt aare eeee iii turss nn 2 INI eeefficinnt,3 ssstem ff simultaneous equations based on variables of life expectancy, infant mortality and economic growth is developed. The findings indicated that income growth per capita affects the growth of life expectancy index positively by 31%, but the growth of social-class differences or income inequality has a negative effect on this index. Moreover, the escalation of health care budget in Iran has led to slumps in infant mortality rate by 83%. Such outcome exhibits the significant role of government, parliament and legislature in approving and improving the budget of the Ministry of Health and facilitating achievement of higher social-health standards. Finally, findings of present study reflected the simultaneous and positive effects of improving growth of life expectancy and reverse effect of infant mortality growth indices on the economic growth of Iran. The estimations provided evidence on the interactions between enhancing the macroeconomic conditions and improving the health economy indicators and existence of a reinforcing loop between them.

Keywords: Life Expectancy; GINI Coefficient; Infant Mortality Rate; Economic Growth; Simultaneous Equations.

JEL classification: H51, H75, I14, I15, I18.

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1. Introduction

The incidence of contagious diseases has led to a lack of concentration of national funds on strengthening economic growth infrastructures, such as investing in education, updating production technology, and modernizing the supply chain structure. Nowadays, community health issues are at the top of the agenda for long-term economic plans. Such problem caused difficulties related to the health sector of the community and the study of quantitative and qualitative factors affecting them to be at the center of attention of economic development issues again. Medical care, health care and community health issues from a quantitative and qualitative perspective have always been one of the most challenging issues in economic development issues and in fact, they are one of the main pillars of sustainable development of health issue and healthy living standards (Boyd, 2014). Therefore, from the macro health management point of view, achieving indicators that improve the uuaii iiii ’’’’’’’’ ’iiee an integral part of the sustainable economic development. The importance mm aaa iit ee’’’’’ ’’ iiee . eeeeaa eeatt ff community has always been one of the main challenges for policy makers in this area. Moreover, according to the World Health Organization (WHO), the provision of appropriate facilities and accommodations for the personal and social health of humans at all stages of life, is one of the natural rights and basic needs of humankind (WHO, 1998). Accordingly, all governments in the world have recognized the right to health care and honored it in their constitution in such a way that maintaining and mm cmmmtttt eeatt eeee hle ctttttt tttt rrr economic-social planning. The importance of the health issues has been reflected in enhancing personal and social growth capacity and increasing the level of economic security in the community, leading to the transformation of human resource into human capital and facilitation of the attainment of higher levels of economic growth and development. The experience of the developed countries suggests that increasing the funds allocated to the healthcare sector in the medium and long term will lead to the improvement of the quality of health services (Acemoglu, D. & Johnson, S., 2007). Additionally, the inclusion of a greater part of the community under the protection of social insurances leads to a reduction

in household health expenditure, which is the basis for sustainable economic growth and development. Furthermore, countries that have experienced economic jumps (such as South America and Japan in the early 20th century, south and South-East Asia in the early 1950s and 60s) have strengthened their economic growth basis by curing common diseases, promoting public health and improving the nutrition status. This is despite the fact that the budget allocated to the health sector in developing countries and the volume of domestic and foreign investment made in this area compared with other sectors show very low levels. These low levels in combination with the allocation of resources wrongly, have led to a state of health in many of these countries in a crisis and a state of emergency (Montgomery, 2009; McFarlane et al. 2000). It is believed that the indiv att eac cmmmtttt affec ooo main factors. That is, the type of service and resource system expended in the health sector. In this connection, the relationship between the resources used for quantitative and qualitative improvement, on the one hand, and the results on the other hand are very important in assessing the operational efficiency of each country in the health sector (Jaba et al., 2014). In this regard, life expectancy and infant and children mortality rates are among the main indices of measuring the performance of health system and by examining them, it is possible to judge the efficiency and effectiveness of each system, along with the appropriate level of health care costs. Although there is a positive correlation between public expenditure in the health sector (health sector budget) and improvement of general health, experimental studies and investigations in different countries have shown that there is a heterogeneous relationship between them. While in some countries such a relationship has been proven, no significant effect has been reported in other countries. Additionally, the way of influencing factors and the type of cause and effect relationships are highly questioned. That is, some studies have suggested that changes in life expectancy are due to changes in economic growth Nevertheless, other scholars have reported economic growth due to the changes in this factor (Cervellati,M, & Sunde, U 2009).

Similarly, some studies have concluded that economic growth is a result of investing and spending in the public health sector (Bakare & Sanmi, 2011; Alshahrani & Alsadiq, 2014; Sheiner, 2014; Alam Mahmud et al. 2013). On the contrary in other studies, increasing health care costs is affected by the economic growth and its outcome (Baiker and Skinner, 2011; Elmi and Sadeghi, 2012; Report of the New York Regional Economic Development Association, 2011). This is despite the fact that the researchers are less concerned with the simultaneous effects of these variables and most studies in this area are based on the hypothesis that there is a unilateral effect based on the classic linear regression approaches. Hence, the lack of a study that targets the simultaneous effects of variables affecting growth and life expectancy is evident. Accordingly, in the current research study, the hypothesis regarding the existence of a unilateral relationship is excluded and by using the simultaneous equation system approach, the interdependence between these variables and the severity of their influence and their simultaneous susceptibility are measured. Focusing on the simultaneous effects of the variables enables the researcher to maintain the dynamic properties of the system and, in addition to examining the interdependence, estimate the degree of their influence and susceptibility. Therefore, it seems that the present study can be innovative in this field.

In this paper, the research history is briefly reviewed in the following section. Then, the theoretical foundations used in the modeling are reviewed. Subsequently, the research variables are introduced and their change procedure is discussed briefly. Finally, having introduced the research method, the research results are discussed and concluded.

2. Literature Review

Health care policies in developed countries have become increasingly important because health cost in most countries of the world has defined as a percentage of gross domestic products and in line with GDP growth; they show an increasing trend over time. According to the macroeconomic theory, increase in life expectancy means that there is a

rrrrrr r eeeel cmmmtttt eeatt add aaallalll tt a heatt workforce whose ultimate effect is on the growth of the savings volume, the provision of necessary financial resources for investment in the production process and the increase of the per capita rate of production (Ray & Linden, 2018). This issue has been confirmed through empirical studies in developed countries as well as developing countries based on time series and cross-sectional data and there is a positive and significant relationship between the cost of health care and GDP per capita growth AAc“llll all , cc c Feee 88888,8%%% improved gross nutrition accounts for roughly 30 percent of the growth of per capita income in Britain between 1790 and 1980. Bloom and Canning (2001) stated that people with a higher life expectancy have a greater incentive to invest in education and obtain higher returns on these investments. By increasing the life span of people through health promotion, the amount of savings (for retirement) increases and therefore the investment process will be facilitated. Research findings on government health costs indicated that increasing public expenditures will lead to positive outcomes. Dehrifi (2018) concluded that increasing public expenditures had a positive effect on the mortality rate of mothers and children under the age of five. Yaqub et al. (2010) found that the increase in health care and gross domestic product costs in the country was associated with an increase in women's life expectancy and was inversely related to the potential years of women's loss of life in Western Europe. Health care costs have explained infant mortality better than GDP. It also showed that increasing health costs makes a significant improvement in women's outcomes, not in those of men. This may be explained by conflicting patterns of mortality, in which the causes of men's mortality, such as violence and accidents, may need less medical interventions and increased public health programs but in women who suffer from breast and cervix cancers, it can be more effective in changing outcomes. Rajkoman and Swaroop (2008) tested the data from 1990/1997 and 2003 regarding the effects of public health costs on the mortality rate of children under the age of five using the quality of bureaucracy and corruption as indicators of the level of governance. In countries with good

governance, one percent increase of public health expenditures in the mortality rate of children under the age of five scaled down the infant mortality rate to 32%. This effect decreases to 20% in countries with moderate government and does not affect countries with poor governance.

Chang and Muntaner (2006) examined a number of variables, including the political environment (ideology and partnership), welfare state policies (transfer of social security and percent of population covered by general practitioner), health care system, income inequality, gross national product and GINI coefficient. Moreover, they investigated the effects of these variables on neonatal mortality rate, mortality rate of children under the age of 5 and rate of low birth weight of children. The GINI coefficient was not significantly related to the infant mortality or low birth weight. This suggests that inequality of income is not the cause for bad health condition, but a result of something else that directly affects the population. The provision of public health services is the only variable that correlates with the mortality of newborns.

3. Theoretical framework

3.1 Health and Economic Growth

If it is supposed that the transfer of technology and knowledge determines the health condition, then it can be argued that lack of effective transfer of drug-based technology and treatment from rich countries to poor countries justifies the present situation of mortality from epidemic diseases in different parts of the world (Shastry and Weil 2002). In the 1980s, a new generation of theories regarding the economic growth came out as a partial response to new dimensions of human capital. These better-equipped new theories could provide better explanations for a long-term growth (Romer 1986; Lucas 1988). One of the underpinning principles of these models pertained to the issue that technology was considered as endogenous to the growth process. The concept of growth as the increased stocks of capital goods was codified in Solow–Swan growth model within the neoclassical growth models. On the contrary, Lucas (1988) and Romer (1986) who added the new concept of capital with increasing rates of return regarded technology as endogenous.

Increased human capital, learning and level of R&D activity came into sharp focus. However, there are a large number of variations in health in rich and poor countries resulting in some differences in income. Higher eeee rrr ee''' eeatt aaa rrrrrr reeee uuuuuuiittt a income differences, resulting in spending more, which improves health and longevity. Therefore, better health was associated with multiple effects. Likewise, the implementation of exogenous health improvements including vaccinations making workers healthier had multiple effects because healthier workers (Weil, 2005) would produce more output. On the one ha , acco "eeatt wwwẅ3ffffere eeatt ennnnnnnnnmn make some income differences among countries. On the other hand, ažitttttttt ttt "aaaaaa awwwẅ ffffeeence eeeeee ceeeeeeeeeaad originated from different aspects of production, which were not related to health in physical capital accumulation or technology. Moreover, Weil (2009) demonstrated that there was a relationship between poverty reduction and long-term economic growth that was influenced by health. The contribution of human capital (including health) to the economic growth was regarded as essential in the early 1990s. Continuous growth and development were directly affected by the levels of human capital whose stocks enhanced due to better education and health and effective procedures for learning and training. A country could not maintain a sustained growth without having a labor force, which has the lowest levels of health and education (Rivera and Currais 2003).

According to Bloom et al. (2004), output was enhanced by health improvements through both capital accumulation and labor productivity. Health and health expenditures had a positive effect on income growth. Health influenced the economic growth in four different ways. Increasing labor productivity, providing greater labor supply, playing the role of a catalyst for education and training which foster higher skills, and calling for more savings, resulting in more investment in intellectual and physical capital were all done by health. Furthermore, Bloom and Canning (2008) argued that health influenced prospective of life spans and behaviors of life cycle. Investments in health were given priority because income was the result of health. The positive impact of a longer life on growth and

development could be counterbalanced by increagggg rrr ee''' average age. Growth was directly influenced by life expectancy. That is to say, the higher the possibility of dying young, the higher the discount rate, making people start working early and stop going to school for longer periods of time FFeee))))))) eee eeeee eeeeeee eeciii eeaa leaving school to start working make life expectancy an important factor eccc aii a ecmmmm aa wwww eee positive impact of a longer life on growth and development could be crrrrrr rr nnnce ccceea rrr ke''' aeeaaee aee I 1111,1 Bhargava et al. attempted to investigate the effect of adult survival rates (ASR) as an health indicator on GDP growth rates in different countries in a five-year interval. Taking the interaction between ASR and lagged GDPc level into account, growth rate models were estimated. Moreover, endogeneity and reverse causality were also taken into consideration. The average life expectancy which was 40 years in 1950 in developing countries, increased to 63 years in 1990. Life span increased by a number of factors including public health infrastructure, better sanitation and innovative medical technologies. In the empirical literature regarding the impact of health on economic growth and development (Bloom et al., 2004; Webber, 2002; Acemoglu, 2011), the main focus of attention was on labor productivity impacts of health on economic development and improvements in health resulted in increasing per capita income because each individual could produce more labor input per unit. In a paper by Finlay (2007), the impact of health on economic development was investigated through two channels of indirect incentive effect and direct labor productivity effect. According to the labor productivity hypothesis, the healthier individuals, the higher returns to labor input. Furthermore, according to the incentive effect, healthier individuals with a higher life expectancy were motivated to invest in education when the time interval for earning returns lengthened.

3.2 Inequality and Economic Growth

Regarding access to health care, education and finance, there are penetrating inequalities. For cushioning market income inequality in

advanced economies, redistribution played a key role. Growth promoting and growth-dampening are two main effects of the increase in income inequality. Cornia and Court (2001) have used data from 73 different countries and concluded that there is a growth-promoting effect for a GINI coefficient value between 0.25 and 0.40. It is noteworthy to mention that there was a growth-dampening effect for the increase in income aaaaaaaa a II NI coeffic aeeee cc
capital is impaired by a high level of income inequality to the extent that people with low income do not access education, capital formation and health care. A high level of income concentration results in using economic power to impose political influence for reducing taxes (Bernstein, 2013). Decreasing the state revenues may reduce investments in both public health infrastructure and education. The economic growth is decreased by the undersupply of public services, lack of public infrastructure and low productivity caused by low expenditures (Galor, 2011). With respect to demand, the demand for goods and services is weakened by a high degree of income inequality. The ensuing savings and capital outflow make less demand when the increasing share of income goes to households with high incomes (Bernstein, 2013). There can be available savings for investment in less developed economies while the continuous consumer demand is missing. The level of capital stock is already high in developed economies. There is no motivation for more investment if there is a decrease in consumer demand. Consequently, besides the potential long- wwww ”””””ec eemmmem
regarding the overall capital stock decreases. This situation stops economic development and results in economic stagnation or contraction
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an increasing level of income inequality weakens future economic development in both supply and demand (Petersen & Schoof, 2015). The wealth distribution would be important for GDPc level and growth if capital markets were not perfect and there were decreasing returns for capital. A higher economic development was supported by redistributing and public intervening in capital markets in this kind of situation because a large number of new investment projects with higher marginal returns

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and effort supply were created by income and wealth redistribution (Aghion et al. 1999). According to Benabou (1996) and Lee and Roemer (1998), there was not a negative and monotonous relationship between inequality and private (human capital) investment. A hump-shaped relationship was found between inequality and growth (Benhabib, 2003). ررررررررر ا هه ههههههههه قتووو .. ييي يييييددذزمه الزنن سسسسسسس growth equation that was a cross-country equation, income inequality had a negative impact on economic growth, while other explanatory variables have been kept fixed. It is worth emphasizing that when GDPc level rose, this impact decreased and it was positive for the richer countries (see also Castello-Climent, 2010). Furthermore, in another related study, the relationship between economic growth and inequality has explored by Cingano (2014) by using data related to the OECD countries during the last 30 years. The findings showed that in the growth equation, inequality measures were negative and statistically significant. Recent research studies indicated that the empirical literature regarding the relationship between inequality and economic growth was biased in favor of significant results representing the impact of inequality on economic growth as being larger. These results are too mixed and confusing. There is not a suitable approach to deal with the impacts of inequality on GDPc. Additionally, the issue that growth rate of GDPc and income inequality influence each other simultaneously is neglected (Baumol 2007; Lundborg and Squire 2003; Huang et al. 2009).

Demographically, Iran is one of the young countries in facing common problems in the region, and so far in line with growth, has had many demands for a wide range of public services. The population will soon become old enough to form a new family, increasing the level of population growth and the need for the infrastructure of public health and services. It is expected that all treatment costs will increase from 24.3 trillion $ in 2008 to 50$ trillion by 2013, indicating an increase in demand for medical services. The total health care costs of Iran in 2005 were 4.45% of gross national product. 73% of Iranians are covered by health insurance (WHO, 2012). The World Health Organization (WHO) declared that the performance level of the healthcare system in Iran is at

the 58th level of health and declared that the overall performance of health system in Iran ranked 93 among the governments of the world (WHO, 2015). The health status in Iran has improved over the last two decades. Iran has been able to provide public health preventive services through the establishment of a broad network of primary health services, resulting in a significantly lower maternal and child mortality rate. Interestingly, the average life span of life has increased since birth. In 2000, the mortality rate of infant and children under the age of five was 122 out of every 1,000 babies and 191 out of 1,000 children under the age of five. This rate decreased to 28.6 and 35.6 out of 1,000 live births[1], compared to 1970. According to r a a eeeeeee888888a rrr models, which are designed from the result of the general plan, the cost of public health as an example is set as:

$$\text{Outcome} = (GDP_{per})^{\alpha} * (\text{Pubexp} / GDP)^{\beta} \quad (1)$$

GDP_{per} is the per capita income and Pubexp is the public health expenditure. GDP stands for gross domestic product and the outcome is the indicator of the health status such as life expectancy, mortality rate of children under the age of five and neonates. Equation (1) shows the outcome (life expectancy) as follows: (a) improves with increasing per capita income; (b) improves (does not get worse) if the proportion of countries whose resources are spent on health care increases. Regarding the logarithm of equation (1), we have the linear form of equation (1) in equation (2):

$$)))) \text{ eeeeee eee}\alpha GGGGG_{per} \quad PPPPPPPPP)))))))) \quad (2)$$

Researchers usually obtain health-care information from public budget documents. Subsequently, Pritchit (1996) wrote about the *p* program as follows:

$$ررر))))^{\prime\prime\prime\prime} \quad p \quad (3)$$

Iran Insurance Annual Report, 2018[1]

(4)

(5)

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In which, *β* represents the general capital productivity that is generated from the costs of the program *p*, and *ϒ(0)* is the government public expenditures. Assuming that the effect of public expenditure is a function of the state of governance, so:

$$\Upsilon(0) = q_0 + q_1 * G$$

This paper considers G as the GINI coefficient and introduced it in an equation as follows:

$$OOOeeeee\ eee{+}{+}{+}\alpha\alpha nn(DDP_{per}{+}{+}\beta\beta_p\ (\Upsilon_0 + \xi_1 G) * \ln(Pubexp / GDP)$$

According to the above equation, the main equation is:

$$HHHSH{=}\delta\delta_0 + \delta\delta_1.\ln(GDP_{per}{+}{+}\delta\delta_2 PPPPPP{+}{+}{+}{+}{+}{+}{+}{+}{+}{+}{+}{+}_3.G + \delta_4.G*\ln(Pubexp / GDP{+}{+}\varepsilon\varepsilon$$

The HS is measured by the health status, which is shown in this study by the infant mortality rate and life expectancy.

4. Data and Methodology

The research variables are life expectancy index, medical care costs, infant mortality rate, per capita national income, and GINI coefficient. National income per capita is an indicator of the economic growth, and GINI coefficient is the fair distribution index of income in the economy, which is between zero and one; GINI coefficient of zero represents zero equality and the coefficient of one represents a completely unequal distribution of incomes. Therefore, GINI coefficient has been selected to investigate the effect of class distinction on the variables of life expectancy and neonatal mortality.

The research period included observations from 1981 to 2018 and the research variables were collected from the World Bank, the World Health Organization, and the Central Bank of Iran. On the one hand, the logarithmic form of the data is used in modeling and the data scale problem is resolved. On the other hand, their growth rate has been studied. Eviews software version 9 has been used for modeling and

estimating. As can be seen in the review of literature, many of the models used in past studies were based on the estimation of a simple linear relationship of a single equation in which the interdependencies of the variables are ignored. In such a situation, the dynamic properties of relationships will be lost, and sometimes researchers will face contradictory results with proven theories (Asteriou and Hall, 2007). To avoid this problem, the system of simultaneous equations is introduced and used, in which not only several dependent variables are simultaneously estimated but also the dependent variable in an equation can appear as an explanatory variable in another equation. Such a characteristic makes it possible for the researcher to use all the information contained in the data vector and to discover the interdependence between the variables. According to the health care literature, life expectancy is affected by medical care costs, infant mortality rates and economic growth rates (Serwalati & Sanda, 2009). This is despite the fact that the mortality rate has been a function of the life expectancy index, the level of economic income and the cost of medical care in that country. (Woods, 2007; Statistical Bulletin of the Wales and England National Statistics Office, 2014). On the other hand, in addition to the distribution of revenues, the rate of economic growth is also affected by the costs of medical care, and the results of numerous studies showed the significant and long-term effect of these costs on the economic growth rate. (Acemoglu and Johnson, 2007; Lusting, 2004). Therefore, in the current study, life expectancy index is a function of variables such as medical care costs, infant mortality rate, economic growth rate and distribution of revenues. Moreover, the factors influencing the rate of infant mortality are presented by variables such as medical care costs, economic growth rate, distribution of revenues and life expectancy index. Finally, the impact of changes in medical care costs, infant mortality rate, life expectancy and distribution of revenues on economic growth in Iran has been estimated. Accordingly, the general form of the simultaneous equation system in this study can be introduced in the form of equations (7) to (9).

$$\begin{cases} \log(Life\_e_t) = C(1) + C(2)*\log(HCE_{t-1}) + C(3)*\log(IM_{t-1}) + C(4)*\log(GDP\_p_{t-1}) + C(5)*\log(Gini_{t-1}) + \varepsilon_1 & (7) \\ \log(IM_t) = C(6) + C(7)*\log(HCE_{t-1}) + C(8)*\log(Life\_e_{t-1}) + C(9)*\log(GDP\_p_{t-1}) + C(10)*\log(Gini_{t-1}) + \varepsilon_2 & (8) \\ \log(GDP\_p_t) = C(11) + C(12)*\log(HCE_{t-1}) + C(13)*\log(Life\_e_t) + C(14)*\log(IM_t) + C(15)*\log(Gini_{t-1}) + \varepsilon_3 & (9) \end{cases}$$

In which, Life_e represents the variable of life expectancy, HCE represents the health care expenditures, IM is the mortality rate of infants, GDP_p represents the per capita domestic income and GINI is the variable of the GINI coefficient. Based on the results of previous studies, the GINI coefficient as a variable that shows the justice of the economic system in the distribution of revenues is not affected by the mortality rate of the infants or the index of life expectancy. Therefore, as an independent variable in the equation system, no equation has been developed for this variable. Similarly, the health care expenditures in developing countries are less influenced by the level of national income, infant mortality rate, and the life expectancy index; rather, they are more influenced by health system decision making and planning (Balaban et al., 2019). Therefore, the variable of health care expenditure in the present study is considered as an exogenous and independent variable. Equations (7) and (9) are the general forms of the simultaneous equation e system and its parameters (C (1) ... C (15)) are the general form parameters. According to the history of studies conducted in this area, the variables considered in the modeling have no immediate and quick effect. For example, the infant mortality rate in the current period is affected by the amount of expenditures or investments made in the health sector during the previous periods. Therefore, in Equation (7), it is assumed that the variables intermittently show their effect. In other words, changes in the life expectancy index in the current period are a function of the distribution of revenues and infant mortality rates in the past. Similarly, the costs of health care and the economic growth rate of the past, explain the changes in the life expectancy index in the current period. Such a hypothesis is also considered in Equation (8), which means that the health care costs incurred in the previous period, the economic growth rate of the past period and the distribution of revenues in the previous year, have an

impact on the rate of infant mortality in the current period. Furthermore, the economic growth rate in the current period is also a function of the lagged values of its explanatory variables in Equation (9).

The accuracy of regression linear models based on Ordinary Least Square Error (OLS) method is estimated through self-correlation tests, heterogeneity of variance and normality of the distribution of wastes. In the simultaneous equation system, the parameters of the general form will be estimated when the order and rank conditions are set. In other words, the establishment of these two conditions ensures the statistical accuracy of the equation system and the interpretability of the model parameters. Based on the rank condition, there will be three states in the system of equations:

$$M = G - 1$$
$$M \succ G - 1$$
$$M \prec G - 1$$

(G) represents the number of endogenous variables and (M) represents the omitted variables in the equation under consideration. Based on the order condition, the number of endogenous variables in the whole system minus one should be equal to the number of variables omitted in the same equation. In this case, the equation system is unique and exactly identified. If M is larger than G-1, the system of equations is over-identified, and in the final state, the system is under-identified. Therefore, in order to establish a system that is exactly identifiable, the general form of the equations must be adjusted and reviewed, with the order condition being established. In the present study, the system of equations (7) to (9) is arranged as follows:

$$\begin{cases} \log(Life\_e_t) = C(1) + C(2) * \log(GDP\_p_{t-1}) + C(3) * \log(Gini_{t-1}) + \varepsilon_1 & (10) \\ \log(IM_t) = C(4) + C(5) * \log(GDP\_p_{t-1}) + C(6) * \log(HCE_{t-1}) + \varepsilon_2 & (11) \\ \log(GDP\_p_t) = C(7) + C(8) * \log(Life\_e_t) + C(9) * \log(IM_t) + \varepsilon_3 & (12) \end{cases}$$

This reduced form of the simultaneous equation system, which is an order condition estimator, is called the structural form of the simultaneous equation system. In equations (10) to (12), it is presumed that: M = G - 1.

Based on the rank condition, the parameters of the structural form of the equations can be interpreted when the coefficients of the exogenous variables are zero and there are no linear combinations between the coefficients of the variables out of the desired equation. Therefore, the rank condition will be established when the determinism of the minor-matrixes of the structural form is non-zero. In Appendix 1, the rank condition has been reviewed and its results have been reported. The rank condition results indicate that the minor-matrix determinants are non-zero and they are derived because of the rank condition. Therefore, the structural form of the simultaneous equation system is statistically correct and its parameters can be interpreted.

5. Research Findings

The trend of changes in the national income per capita index shows decreasing and increasing periods. Considering the structure of the Iranian economy that is mainly based on oil revenues, global oil price changes and intensification of economic sanctions especially in 2010 and 2011 can be considered as the main drivers of such fluctuations which are well visible in the chart. Chart (1) shows the trend of changes in the life expectancy index and health care costs.

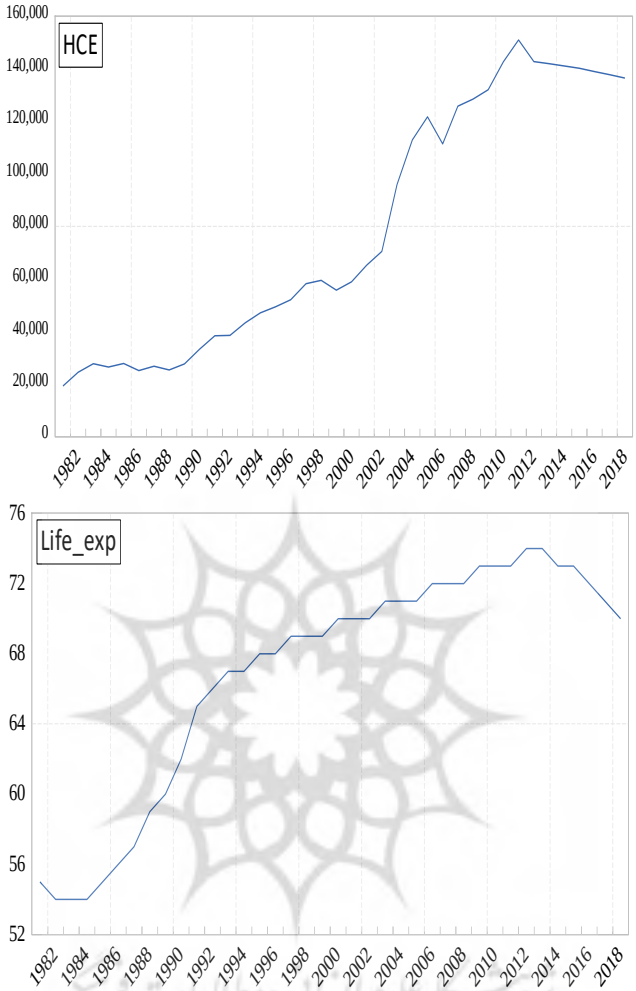

Fig. 1: The trend of changes in the health care expenditures and life expectancy index during 1981-2018

Despite the fluctuations in national income, the health care expenditures, reflecting the budget paid to the Ministry of Health, show an incremental trend (from $ 19 million in 1981 to $ 141 million in 2014), which highlights the importance of this sector in the structure of the socio-economic system of Iran. The trend of changes and fluctuations of the other research variables is presented in Appendix (2). By increasing the health budgets, it is expected that the proportional distribution of them will reduc th bbbiss' mrr talit rtt A aan be seen in the SBB's Chart, the index decreased from 86 levels in 1981 to 14 in 2018, showing an average of 84% significant decline and it can be considered as successful in this regard according to the allocated budget, health policy and performance. The increase in per capita national income, coupled with an

increase in health annual budgets in addition to reducing the infant mortality rate, has led to a growth rate of life expectancy. Life expectancy has reached from 55 in 1981 to 77 in 2014, indicating a growth rate of 40%. In sum, despite the lack of Iran's health standards compared to developed countries, given the level of health care annual budget (influenced by several factors such as sanctions, war, exchange rate fluctuations, management change, etc.), the achievements of this section are very successful for these variables. The results of estimating the structural form of the simultaneous equation system are summarized in Table (1).

Table 1: The results of estimating the parameters of structural form of the simultaneous equation system

	Constant	Life_e	IM	GDP_p	HCE	GINI
Eq (1)	4.4198 (9.8764)	*	-	0.3147 (4.5884)	-	-0.0901 (-3.2737)
Eq (2)	13.9512 (162827)	-	*	-0.3389 (-2.7007)	-0.8363 (-22.5395)	-
Eq (3)	4.1486 (2.1885)	0.4219 (3.6588)	-0.6055 (-7.2215)	*	-	-
Estimated and the * denotes the dependent variable in each equation Note: In parentheses the t-coefficients are reported Source: Research findings						

Before interpreting the model estimation results, it is noted that the critical values at a significance level of 95% in the t-distribution are equal to 2 and (absolute value) the higher values represent the confirmation of the statistical validity of the estimated coefficient. Given the estimated coefficients for parameters of the structural form of the simultaneous equation system, and especially the t coefficients, which are all more than critical values of ±2/2, the statistical accuracy of all the parameters of the model is confirmed. The variation in the variable of life expectancy in the chart shows an increasing trend. Moreover, the changes in the national income per capita indicator in Appendix (1) also indicate a relative increase in this variable over the research period. This induces a positive per capita national income effect on the life expectancy index. The GINI coefficient shows a decreasing trend, which induces a negative effect on life expectancy. The linear form of the first equation is given in the form of relation (13):

$$\ln(Life\_e_t) = (4.4198) + (0.۷۷۷۷)*\ln(GDP\_p_{t-1}) - (0.۱۱۱۱)*\ln(GINI_{t-1}) \quad (13)$$

Based on the above equation, there is a positive and significant relationship between the growth of the life expectancy index and per capita national income. This finding suggests that by increasing the national income per capita in Iran, life expectancy has increased. The rate of influence of national per capita income is estimated at 31%, which states that a 1% increase in per capita national

income growth in the previous period has led to a 31% growth in the life expectancy index in the current period, indicating a high sensitivity and response of life expectancy to this variable. The growth of the per capita national income can be seen as a sign of economic growth and an increase in socio-economic prosperity, which has led to the expansion and increase of public services (such as health, educational and welfare services), promotes people's life expectancy, which is theoretically acceptable. Furthermore, the elasticity of the life expectancy index relative to the GINI coefficient variable indicates the negative reaction of this variable, which means that by increasing the GINI coefficient, life expectancy in Iran has decreased. As noted earlier, the GINI coefficient is an indicator of the fair distribution of revenues and is in the range of zero and one (zero = full equality of income distribution and one = quite unequal distribution). The findings of this study indicate that by increasing the growth rate of the GINI coefficient (moving towards inequality of income distribution), the life expectancy index has declined by a negative reaction to it. In fact, by increasing inequality in income distribution, which can be interpreted as an indicator of the expansion of class distinction, the growth rate of life expectancy in Iran has declined. The sensitivity and elasticity calculated for this coefficient is 9%, indicating that for 1% increase in the growth rate of the GINI coefficient in the previous period, the growth rate of life expectancy in the current period is reduced by 9%, which is a worrying figure. In Chart (1), the variable of health care expenditures has always experienced a growth rate and an incremental trend, while the chart of the infant mortality rate in Appendix 1 shows a decreasing trend. Accordingly, the negative impact of health care expenditures on infant mortality is expected. Moreover, the increasing trend of the per capita national income in Iran and the decreasing trend of infant mortality rate induced a negative effect on the per capita national income increase and on infant mortality rate. The linear form of the second equation is given in the form of relation (14):

$$\ln(IM_t) = (13.9512) - (0.3389)*\ln(GDP\_p_{t-1}) - (0.8363)*\ln(HCE_t) \quad (14)$$

According to this equation, there is a negative relationship between the growth rate of infant mortality in the current period and the growth rate of national income per capita in the previous period. In other words, by increasing the per capita national income in Iran, the infant mortality has declined, which is theoretically acceptable. The growth of per capita national income suggests an increase in economic well-being and, consequently, an increase in the level of health services, leading to increasing health and medical care for pregnant mothers, on the one hand, and increasing the support for medical care services to a wider range of the community and more people, on the other hand. The outcome of all these cases is a reduction in the rate of infant mortality that has been confirmed in the present study and in the case of Iran. Estimated elasticity for this coefficient is equivalent to 33%, which indicates the high sensitivity of the infant mortality rate to the growth of per capita national income. The

estimation of the effect of the growth rate of health care expenditures on infant mortality rate indicates the negative effect of this variable on the mortality rate of newborns. The finding suggests that by increasing the funds of the Ministry of Health in Iran, the infant mortality rate has been reduced, and it is theoretically approved. In fact, by increasing the amount paid to this sector, the Ministry of Health has been able to reduce the rate of infant mortality by spending these funds in different areas, and in particular increasing the privilege level of disadvantaged areas of health services. The elasticity of the variable of infant mortality rate to changes in health care expenditures, is estimated to be 83%, which shows a very high sensitivity. In fact, it can be stated that health care expenditures are one of the most important variables affecting the reduction of infant mortality rate in Iran. The important finding of the present study in the third equation lies in the structural form of the simultaneous equation system, which reflects the interaction of the endogenous variables of the model. As shown in the charts of the per capita national income, life expectancy index and infant mortality rate, the first two variables indicated incremental trends and infant mortality rate represented a decreasing trend. Hence, HCE_t variable expects a positive effect of life expectancy through the channel of national income growth (economic growth) and negative impact of rising infant mortality on economic growth. The linear form of the third equation is given in the form of relation (15):

$$\ln(GDP\_per_t) = (4.1486) + (0.4219)*\ln(Life\_e_t) - (0.6055)*\ln(IM_t) \quad (15)$$

Equation (15) indicates a negative relationship between the growth rate of national income per current period and the rate of infant mortality in the same period. In other words, by increasing the rate of infant mortality, per capita national income in Iran has declined. An increase in the mortality rate of newborns has a deterrent effect on population growth and slows down its increase rate. Theoretically, all macroeconomic theories emphasize human resources (and especially human capital) as one of the main factors of production and a slowdown in its growth rate can lead to a decline in economic growth. Based on the results of this study, the existence of such an effect on Iran's economy is confirmed. The elasticity of economic growth relative to the mortality rate of infants is estimated to be equivalent to 60% of infant mortality rate, indicating the high sensitivity and high impact of this phenomenon on economic growth. One of the reasons for the high rate of this factor is that the mortality rate of the infant and the life expectancy index are among the most important indicators of development. Countries with high infant mortality rates are often found in underdeveloped countries, which, along with low economic indicators, have very poor medical and health standards. Some of the earliest areas that have shown significant growth regarding economic development are nutrition, health services and education. In order to achieve a reduction in infant mortality rates, productive investments have to be made to improve the quality of the above-mentioned services. Therefore, the reduction in the infant mortality

rate is a result of a series of productive and influential activities in the economy, health, education and nutrition and it is one of the hallmarks of economic growth and development. Consequently, the reduction in infant mortality rate includes the effects of a series of processes for qualitative development of health, medical, educational, and nutritional services, and it has a great weight in the third equation which is the growth equation. There is also such a finding about the life expectancy variable. The effect of the life expectancy variable on economic growth rate has been estimated as positive, which indicates an increase in the growth rate of per capita national income relative to the increase in the life expectancy index. As for the variable of infant mortality rate, the life expectancy index is one of the most important indicators of economic development, and the increase in this variable reflects the quality improvement ff livi stnnrrr d nn th eeee lppmnnt of eelll ’’s leeel of nnjyymnnt from various public and private services. This quality of life enhancement encourages human resources to work quantitatively and qualitatively and it boosts economic growth. The findings of the present study revealed the existence of this issue in Iran's economy.

According to the first equation, the positive and significant effect of national income growth on life expectancy index was extracted and it obtained an elasticity of 31%. In the third equation, the mutual relationship of this effect has been investigated and the impact of life expectancy index on the growth rate of per capita income has been studied. The obtained cross elasticity is positive and statistically significant, which gives a sensitivity of 42%. This finding is important in different ways. First, there is a dynamic bilateral relationship between the economic growth variable and the life expectancy index in Iran's economy, which means that there is a mutual relationship between these two variables that should be taken into consideration by researchers in the studies carried out in this area. Secondly, the impact of life expectancy on economic growth has been positive and its interaction, i.e., the impact of economic growth on the life expectancy index, is also positive, which reflects the synergistic effect of these two variables on each other. In other words, the positive economic growth rate will lead to an increase in the life expectancy index and the promotion of the life expectancy will boost economic growth. Third, the estimates suggest a more powerful effect of the life expectancy index on economic growth than the effect of the national per capita income growth on the life expectancy index. This point indicates that in the growing economy of Iran, along with all the low-effective elements that have an impact on economic growth, the role of qualitative factors is also very important and such variables should be used in empirical studies and in modeling. This is also the case with the variable of infant mortality rate. In the second equation, the negative and significant effect of the national per capita income growth on the infant mortality rate was extracted and in the third equation, the negative and significant effect of the rate of infant mortality on the economic growth rate is estimated. The

elasticity of infant mortality rate versus economic growth has been calculated at 33%, while its cross elasticity is estimated at 60%. This finding reflects the dynamic relationship between these two variables, on the one hand, and more susceptibility of economic growth to the infant mortality rate, on the other hand. Thus, the role of human resources in the economic growth of Iran has been re-emphasized.

Considering the positive and significant impact of health care expenditures on the infant mortality rate in the second equation and the negative effect of infant mortality rate on the economic growth in the third equation, the positive and indirect effects of health care expenditure on economic growth can be extracted. The findings suggest that the costs incurred in the health sector have positive externalities so that their final impact on increasing Iran's economic growth has been observed. Based on this, the approach and vision of policymakers, decision makers and macroeconomic management to healthcare expenditures should not be in the form of financial costs, but as investment funds. In fact, the findings of this study indicate that the increased budget paid for the health sector has improved the qualitative indicators of the economic development (such as life expectancy and infant mortality rates) and these factors in turn have led to an increase in the rate of the economic growth.

One of the main goals of this study was to investigate the effect of health care expenditures on life expectancy. In this research study, in order to satisfy the order condition and the interoperability of estimated parameters, this variable was eliminated from the structural form of the life expectancy equation (Equation (9)). However, the effect of this variable can still be traced on life expectancy. Thus, according to relation (13), the negative and significant effect of health care expenditures on the mortality rate of newborns was estimated and simultaneously (14) the negative effect of infant mortality rate on economic growth was estimated. Accordingly, the positive effect of health care expenditures on the growth rate has been proven, and in relation (12), the positive effect of economic growth on the variable of life expectancy was obtained. As a result, the positive and significant effect of health care expenditures on life expectancy can be extracted. In other words, in the present study, the health care expenditures through the channel of infant mortality rates and the channel of economic growth rate have affected the life expectancy variable and this effect was a positive and significant one.

$$Log(GDP\_p_t) = (4/1486) + (0/4219)*Log(Life\_e_t) – (0/6055)*Log(IM_t) \quad (16)$$

6. Conclusion

Health care and community health issues from a quantitative and qualitative point of view have always been one of the most challenging issues in economic development issues, and in fact, they are one of the main pillars of sustainable development of health issue and standards of healthy living. Nowadays, the variables related to the community health sector have been given priority in

long-term economic modeling and planning. Moreover, the issues related to the health sector and the impact and susceptibility of the quantitative and qualitative factors affecting them and economic growth are at the center of attention of economic development issues. Life expectancy index, infant mortality and children mortality rates are among the main indicators of measuring the performance of health system and by examining them, the effectiveness of each health system can be judged along with the appropriateness of the level of health aar eeeeiii trr ss ee 111 ii l, th .eeearhhrr s' fcc mmpsss. tee existence of a simple linear relationship between these variables and the lack of studies targeting the simultaneous effects of these variables were the main motives behind the current study. In the present study, the hypothesis of the existence of a unilateral relationship was set aside and by using the simultaneous equation system approach, the interdependence of economic growth variables, life expectancy and infant mortality rate along with the variables of GINI coefficient and health care expenditures were investigated and the severity of their simultaneous impact and susceptibility were studied. The selected period was the annual statistical data for the years 1981-2018, collected from the World Bank, the World Health Organization, and the Central Bank of Iran. Selected variables were evaluated in a logarithmic form and within the framework of the simultaneous equation system. Accordingly, the life expectancy index, infant mortality rate and economic growth were endogenous variables and health care expenditures and GINI coefficient were considered as exogenous variables of the model, showing the establishment of three structural equations. The findings of the present study suggested that there is a dynamic and mutually positive relationship between the life expectancy index and the economic growth rate. This is also the case with the variable of economic growth and the rate of infant mortality. The estimates suggested a positive and significant relationship between economic growth and life expectancy and the economic growth response has more elasticity than the life expectancy index. The life expectancy index has reacted negatively to changes in the GINI coefficient, which suggested that by increasing the equality in income distribution in Iran, the level of life expectancy is decreasing. Furthermore, by increasing the per capita national income in Iran, the mortality rate of newborns decreases, indicating the welfare effect of increasing income and expanding the availability of health services for more people. In addition, by increasing the health care expenditures, the mortality rate of infants has decreased significantly indicating the importance of the amounts allocated to the Ministry of Health and the high elasticity of the mortality rate of infants relative to the budget. The simultaneous equation system indicated the positive and indirect effects of budgets paid to the health sector on the growth rate due to the reduction of infant mortality and increased life expectancy. The effect of health care expenditures on life expectancy has been positive and significant, which has been shown by the variables of infant mortality rate and economic growth rate. Based on the findings of this study, it is

suggested that policymakers and decision makers of the macroeconomic and community health sector pay attention to the interaction of these variables and stop seeing the health sector budget as a cost factor, but as an investment in planning and modeling in these sectors.

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APPENDIX

Appendix.1

	Life_e	SBB	GDP_p	HCE	GINI
First equation	√	0	√	0	√
Second equation	0	√	√	√	0
Third equation	√	√	√	0	0

Minor of the first equation:

SBB	HCE
””	0
√	√

Minor of the second equation:

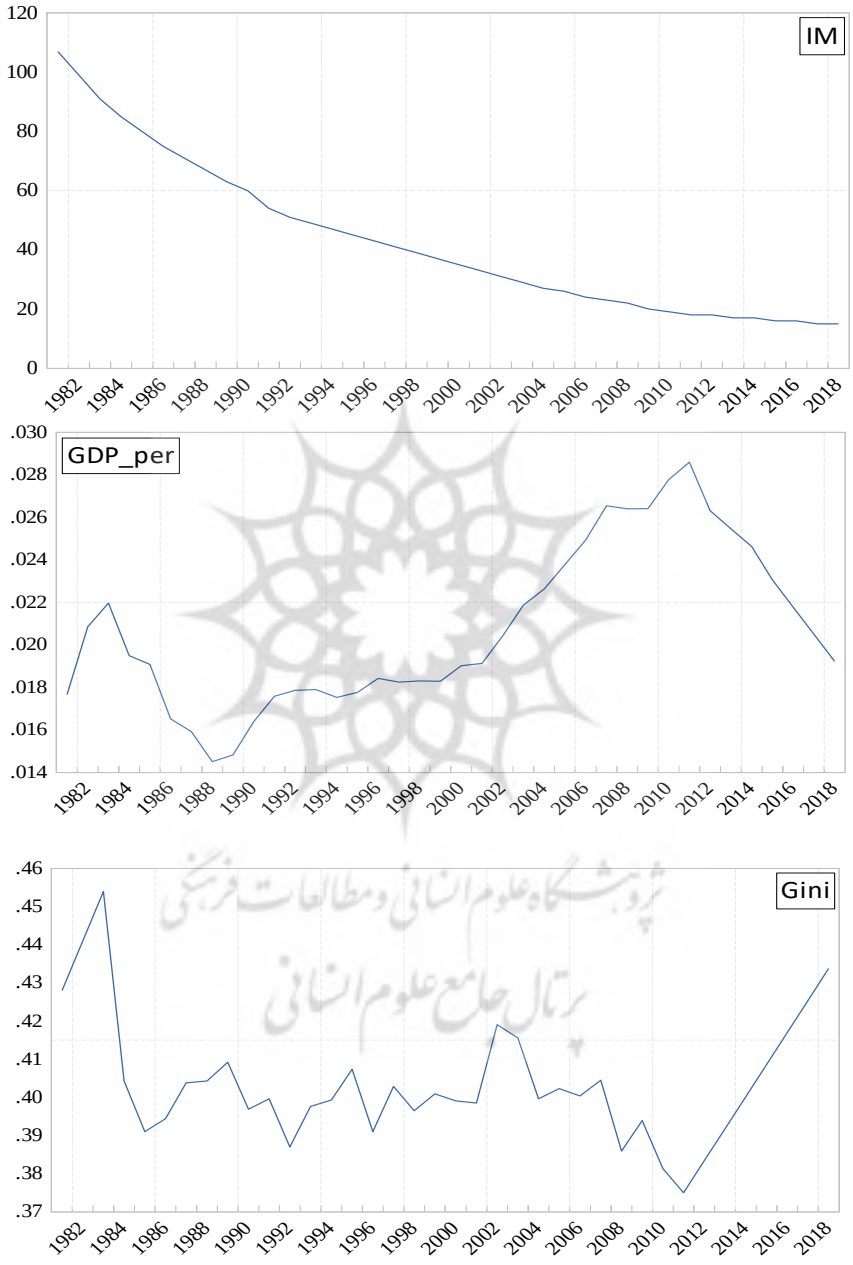
Life_e	GINI
√	√
√	0

Minor of the third equation:

HCE	GINI
0	√
√	0

As you can see, all minors have non-zero determinations, and so the equation system has statistical accuracy and the estimated coefficients for the structural form parameters can be statistically interpretable.

Appendix.2 Trend of Changing the Variables of Research



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چکیده

امید به زندگی و مرگ‌ومیر نوزادان ازجمله مهم‌ترین شاخص‌های ارزیابی کارایی سیستم سلامت اجتماعی محسوب می‌شوند. حجم بزرگی از مطالعات انجام شده در حوزهٔ اقتصاد بهداشت مربوط به اثرات خط ی و یک‌جانبهٔ متغیرهای اصلی کلان اقتصادی ازقبیل نابرابری درآمد و رشد اقتصادی بر روی شاخص‌های اقتصاد بهداشت بوده‌اند و کمتر به اثرات دوجانبه و هم‌زمان توجه شده است. ازا ین‌روی، مقاله حاضر به بررسی اثر دوجانبه و هم‌زمان متغیرهای اشاره شده در اقتصاد ایران می‌پردازد. بدین‌منظور، دستگاه معادلات هم‌زمان مبتنی‌بر متغیرهای امید به زندگی، مرگ‌ومیر نوزادان و رشد اقتصادی با درنظر گرفتن ضریب جینی در معادلات طی دورهٔ زمانی ۱۳۹۵-۱۳۶۰ برآورد گردیده است. یافته‌ها نشان می‌دهند که رشد درآمد ملی به‌طور مثبت و با ضریب تأثیر ۳۱٪ شاخص امید به زندگی ایرانیان را تحت‌تأثیر قرار می‌دهد، ولی رشد اختلاف طبقاتی و نابرابری درآمدی، اثری منفی بر این شاخص داشته است. هم‌چنین، با افزایش بودج ۀ مراقبت و بهداشت در ایران، شاخص مرگ‌ومیر نوزادان رشد منفی چشم‌گیر ۸۱٪ را تجربه نموده است که اهمیت نقش مجلس و قوهٔ مقننه در تصویب و ارتقاء بودجه وزارت بهداشت و تسهیل دست‌یابی به سطوح بالاتری از شاخص‌های بهداشتی و سلامت را نشان می‌دهد. درنهایت، برآوردها بیانگر اثر هم‌زمان و مثبت بهبود رشد شاخص امید به زندگی و اثر معکوس افزایش رشد مرگ‌ومیر نوزادان بر رشد اقتصادی می‌باشد. یافته‌های این پژوهش نشان‌دهندهٔ وجود یک «حلقهٔ تقویت‌کننده» بـ ین بهبود شرایط اقتصادی و بهبود شاخص‌های اقتصاد سلامت است و شواهدی مبنی‌بر وجود رابطه‌ای متقابل و دوجانبه بـ ین متغیرهای لی ن دوحوزه در اقتصاد ایران به‌دست آمده است.

کلید واژه‌ها: امید به زندگی، ضریب جینی، نرخ مرگ‌ومیر نوزادان، رشد اقتصادی، سیستم معادلات هم‌زمان.

طبقه‌بندی JEL: H51, H75, I14, I15, I18.

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