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The Impact of Economic Growth, Employment and Income Distribution on Water Consumption in Iran

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Abstract

Factors such as population growth, rapid urbanization growth, the development of economic activities and irregular utilization of environment have left its impact on the environment, including water resources. Water resources management is based on the balance between water supply and demand, while in recent decades , water demand to balance establish under the influence of economic growth and economic development and social and political drivers, has been increased. This has led to a shortage of water resources and increasing gap between water supply and demand in Iran.

The aim of the paper is to examine the effects of economic growth, employment and unequal distribution of urban and rural income on water consumption using the panel data in Iranian provinces during the period of 2005-2016. In this study, the Herfindal-Hirschman (HHI) and Shannon (E) unequal indexes have been used to measure the income inequality in urban and rural areas. Also, the fitted models are based on the GMM two-step approach. The results show that economic growth, employment, and unequal distribution of income have a positive and significant effect on water consumption. In addition, water consumption has a direct relationship with urban development and reverse relationship with the rainfall average.

Keywords: Economic Growth, Employment, Herfindal-Hirschman, Shannon, Water Consumption

Introduction

One of the major challenges of the 21st century is the scarcity of water resources. According to estimation by World Water Council, 4% of the world's population has experienced water scarcity and is likely going to reach 50% by 2025(Yue et al.,2017).

Iran is located in the dry and semi-arid region of the world. The amount of its renewable resources in terms of rainfall situation, vegetation and other effective factors in the volume of atmospheric precipitation is 130 to 139 billion cubic meters per year, which its recoverable volume is estimated about 126 Billion cubic meters. While the total annual water volume is constant, the demand for water has reduced the average per capita amount of renewable water due to the population growth, agricultural development and industry during the recent years, which was about 2,100 cubic meter in 1997 ,in 2006. This average had dropped to around 1750 cubic meters , and will drop to around 1300 cubic meters in the horizon of 2021.

Concerns related to the water scarcity, along with the conditions of the recession and the employment crisis, have led prioritizing the growth and economic development of the country or the preservation and sustainability of water resources keep in policy makers' mind . In the past decades, water consumption has been in line with economic growth in countries, but in recent years, developed countries have achieved higher economic growth without increasing water consumption, while in Iran, The reverse relationship holds and economic growth is considered as a threat for water.

Water consumption is divided into three categories of urban, agricultural and industrial water use. The agricultural sector like a intensive water use is economic growth engine . It is clear that economic growth requires water resources, as well as other energy sources, while Iran is facing a shortage of water resources. Therefore, increasing economic growth requires water efficacy management. Based on microeconomic analysis, shortages of water supply or surplus demand for water, means that supply and demand, can not be balanced, which results in more consumption of resource capacity. Lack of proper water management confront a major challenge to economic growth. According to UNESCO, 78 percent of the world's businesses, such as agriculture, fisheries, mining, etc., depend on water . Moreover, economic policy makers have always emphasized the policy of self-sufficiency of wheat and other agricultural products, which also result in excessive use of the country's water resources .

According to the above, the main purpose of this paper is measuring the effects of economic growth, employment, and income distribution on water consumption using the GMM two-step technique. This article contains five sections. Following Introduction in part 1; in the second part, the theoretical background and studies on water demand will be described; in the third section, the model and method of research are discussed; in the fourth section, the empirical results are examined, and in the final section Conclusions and policy recommendation will be presented.

Literature and research background:

Ninety percent of Iran's water is used on agriculture, and water in the industrial sector is considered as a major factor. The demand for water in the industrial and agricultural sectors, is examined as well as demand for the factors of production and intermediary goods (Faraji Dizaji, 2009).

Easterly (2001) emphasizes that inequalities, on the one hand, are one of the main reasons for slowing down of economic development and, on the other hand, maintains undesirable pressures on ecosystems related to sustainable development

The atmospheric variables are considered as one of the factors affecting water demand. Many studies have been done in this regard, including Martinez (2002), who believes that the effect of rainfall on water consumption is more psychological and uses the variable number of rainy days as a proxy for rainfall in the water demand function and states that this variable is a stronger explanatory variable than the rainfall variable.

In his study on economic growth and water use, Matthew (2006) states that there is a systematic relationship between water consumption and income, and his research, based on regional projections, shows that water use in developing countries is on rise .
Income gap is another factor in water demand. Johnson and Scholes (2006) believe that the price elasticity of water demand for lower-income deciles is 0.23, and for the upper-income families is -0.99. The results of the study showed that a one percent increase in per capita income would result in an increase in water consumption by 5%, and a 2% increase in water prices by 2020 would reduce 10% of water consumption.
Nauges and Wittington (2010) fitted the demand for water in developed countries and concluded that water management should be promoted in less developed countries for better use of domestic water.
Qin et al. (2012) expressed that water is considered as a factor in production, and applying taxation on water could result in the reallocation of regional water resources and changes in economic variables such as value added and trade pattern as well as water taxes has the greatest impact on agriculture sector.
Parker and wilby (2013) in assessing household water demand in the UK have shown that considering the relationship between atmospheric variables and household consumption demand are one of the most important factors affecting urban water demand.
Yu et al. (2017) examined the relationship between industrial water consumption and economic growth in China based on the Kuznets environmental curve, using data on per capita industrial water consumption and GDP in eight Chinese economic regions during the 2002- 2014, showed that the increase in industrial water consumption in China corresponds to the characteristics of the EKC and there is a reverse U-shape relationship between industrial per capita water consumption and GDP.
In Iran little research has been conducted on the factors affecting water demand. Jabal Ameli and Gudarzi Farahani (2012) examine the effect of subsidies on Qom urban water sector using the maximization of the Stone Gray utility function and the Var approach and show that the reduction of subsidies to water consumes results in a decrease in the amount of water consumed Up to 42 liters per day.
Firuzi et al. (2015) studied the effect of subsidy reform on water demand in Tehran. The results showed that the subsidy reform did not affect the amount of urban water demand. In addition, urban water demand has an opposite relationship with the price of water and direct relationship with income. Urban water demand is inelastic and it is a necessity good.
A great deal of analysis has been done in recent decades on estimating the water demand function, but little studies has been done about the impact of economic growth, employment, and income distribution on water consumption.

Research Methodology

In this paper, the two-step GMM approach has been used to estimate the relationships between variables. Model estimation using GMM dynamic panel data is the most appropriate method of econometric analysis to solve the endogenous problem of explanatory variables. The existence of a lagged dependent variable makes the assumption of the lack of auto correlation between the independent variables and the error terms violated. Appling GMM method by using the instrument variables eliminates this objection (Pedram and Hafeziyan, 2016). The two-step GMM and GMM estimators provide the possibility of introducing more tools and improving the efficiency of the coefficients. For this reason, in the present study, fitness is carried out through a two-step GMM approach, which increases the efficiency of estimated results. In order to make sure that the method is appropriate to evaluate the model, we have two tests, one of these tests is the Sargan test, which is used to prove the validity of the oreridentification, that means the reliability and validity of the instrumental. The second test is the first-order AR (1) and second-order AR (2) residual correlation test. This test is also used to check the reliability and validity of instrumental variables.

Model specification:

In order to investigate the effect of economic growth, employment and distribution of income on water consumption in Iran, the following equations are specified:

$Lwat_{it} = \beta_0 + \beta_1 PGDP_{it} + \beta_2 Emp_{it} + \beta_3 HHI + \beta_4 Lurb_{it} + \beta_5 Rai_{it} + \eta_i + \varepsilon_t$ (1)

$Lwat_{it} = \Upsilon_0 + \Upsilon_1 PGDP_{it} + \Upsilon_2 Emp_{it} + \Upsilon_3 E + \Upsilon_4 Lurb_{it} + \Upsilon_5 Rai_{it} + \eta_i + \varepsilon_t$ (2)

In which $Lwat_{it}$ water consumption usage per capita, $PGDP_{it}$ is the real gross domestic product per capita, Emp_{it} is the ratio of the employed to the total population, HHI and E, respectively, of Herfindahl-Hirschman and Shannon indicators for measuring income inequality in urban and rural areas.

It should be noted that in the analysis of inequality, the parametric and nonparametric methods can be used. In the nonparametric method, one or more indicators of inequality are calculated and investigated using direct observations without using a specific model. But in the parametric method, the income distribution model is used. In other words, in this method, probability distribution functions and probability density functions are used to evaluate inequality. The major difference between the two methods is that the nonparametric method necessarily reflects the result of only one sample and ignores the sampling error. While the patterns leading to the parametric methods, reflect the outcome received by the society, the Herfindahl -Hirschman and Shannon indexes are part of a nonparametric approach. (Shahikhi Tash et al., 2007).

If in the income distribution function, the individual i income, the total income , and the distribution of the society income share having n members respectively are shown with x_i , x and the vector $\{x_1 / x, x_2 / x, ..., x_n / x\}$, so that the individual i income share to the total income x_i / x and μ be the average income In this case, the Herfindahl-Hirschman Income Inequality Index is defined as the sum of the square income share of all individuals in the community. With the help of the following statistics, we can calculate the indicator we present with HHI:

$$HHI = \sum_{i=1}^{n} \left(\frac{x_i}{\sum_{i=1}^{n} x_i}\right)^2 = (n\mu)^{-2} \sum_{i=1}^{n} x_i^2$$

In the science of statistics, the entropy index is an indicator that measures the information available in the frequency distribution of a variable, in fact this index is extracted from the information theory. In the information theory, the Shannon entropy index or the entropy of Shannon or the entropy of information are known as a measure of uncertainty and also as an indicator of information mean measurement . Using the information entropy index, one can calculate inequality, which in the income distribution literature is referred to as the Shannon entropy index. This index is defined as:

$$E = \sum_{i=1}^{n} x_i / \sum_{i=1}^{n} x_i \ \log\left(x_i / \sum_{i=1}^{n} x_i\right)^{-1} = \sum_{i=1}^{n} x_i / x \ \log\left(x_i / x\right)^{-1}$$

If the vector $\{x_1 / x, x_2 / x, ..., x_n / x\}$ represents the relative contribution of each decile, according to the structure of this index, the income share of each decile x_i / x is weighted by the logarithm of reverse income share . This indicates that Shannon's first order entropy index is more influenced by low-deciles income changes.

The main difference between E and HHI indices is that the HHI index is a concave function of the income share of the deciles, while the E index is a convex function of the income share of the deciles. If the E index is constant over time, while the HHI and Gini ratios are increasing over time (cov (HHI, Gini)>0), this suggests that the increase in inequality is due to the increase in the income share of the High and moderate deciles (rich and middle-to-high households). If the HHI index is constant over time, while the E and Gini ratios are increasing over time (Cov (E, Gini)>0), this suggests that the increase in inequality is due to an increase in the gap in the income share of low deciles (poor) (Shahikhi Tash et al., 2007).

For this purpose in model (1) the Shannon index is to be fixed and in model (2) Herfindahl-Hirschman index is to be fixed. It is worth noting that according to the Iranian Statistics Center, the index of Gini

coefficient during the sample period has dropped from 0.43 in 2006 to 0.37 in 2011, but from 2011 onwards, it increased to 0.39 in 2015.

In the following, control variables include the urbanization (Lurb) and average rainfall (Rai). Also, ε_t and η_i respectively represent the individual effects of time and error terms. Indices i and t represent the province and time.

Empirical results of the model

The relevant models for better controlling of the induction of explanatory variables and solving the auto correlation problem are estimated by two-step GMM estimator using the Stata12 software. The results of models estimation are presented in table (1) and table (2).

Table 1 . Models estimation results (1) using the HHI index

1. Dependent Variable: Lwat		
4. Explanatory Variables	**3. Coefficients**	**2. Prob**
7. Lwat(-1)	**6. 0.8748648**	**5. 0.000**
10. PGDP	**9. 0.0000257**	**8. 0.000**
13. Emp	**12. 0.1408439**	**11. 0.031**
16. HHI	**15. 0.2376102**	**14. 0.000**
19. Lurb	**18. 0.2057933**	**17. 0.000**
22. Rai	**21. -0.2057933**	**20. 0.000**
25. Constant	**24. -0.2505083**	**23. 0.000**
27. Sargan test	**26. 0.8792**	
29. AR(1)	**28. 0.9526**	
31. AR(2)	**30. 0.3304**	

Table 2 . Models estimation results (2) using E index

		Dependent Variable: Lwat
Explanatory Variables	Coefficients	Prob
Lwat(-1)	**0.8944319**	**0.000**
PGDP	**0.0000387**	**0.000**
Emp	**0.2222906**	**0.000**
E	**-0.4099727**	**0.000**
Lurb	**0.0991276**	**0.027**
Rai	**-0.000077**	**0.000**
Constant	**0.0614839**	**0.051**
Sargan test		**0.2362**
AR(1)		**0.9733**
AR(2)		**0.3337**

As shown in table (1) and table (2), the results indicate that increasing economic growth (PGDP)is in line with water consumption changes. Moreover, an increase in employment (Emp) also leads to an

increase in water consumption. This means that the shortage of water supply, will limit economic growth and job creation in the coming decades. According to the estimates, half of the workforce in the world works in 8 water and natural resources industries, so water and employment are interconnected and dependent in the economic and environmental fields. From the time of extraction to its return to the environment, water will play an important role in creating employment due to different exploitation. Studies have done in the United States show that every 1 million dollar investment in the traditional water and wastewater systems can create about 10 to 20 lateral jobs.

In this regard, in recent years, from the green economy point of view, economic growth is consistent with the sustainability of the environment and water resources and creates new employment opportunities. The green economy means the separation of economic growth category from resources. The realization of the separation from resources means the economic growth rate is higher than the resources consumption growth rate, which is followed by structural changes in business, energy and macroeconomic processes.

As can be seen, Herfindahl-Hirschman income inequality index (HFH) has a positive and significant effect and Shannon's index (E) has a negative and significant effect on water consumption. In the previous section, it was stated that by comparing the results of Shannon (E) and Herfindahl-Hirschman (HHI), important information is obtained about the changes in the share of inequality between deciles. The important difference between the two indicators is that the HHI index refers to the changes in the income share of the top deciles and the E index refers to the changes in the income share of the lower deciles.

Since the Shannon index (E) is assumed to be constant in model 1, and the HHI index is increased alongside the Gini index, it can be concluded that the increase in inequality due to the increase in the share of high incomes (citizens) leads to an increase in water consumption, and in model (2), which assumes the Herfindahl-Hirschman index (HHI) is constant, by increasing the Shannon index alongside the Gini coefficient, it can be concluded that increasing the income share of the lower deciles (villagers) leads to a reduction in water consumption. Therefore, reducing the social gap between the city and the village and the fair distribution of income will lead to improved water consumption.

Urban level variable (Lurb) is positive and statistically significant, and also the effect of rainfall variable (Rai) is negative on water consumption, which is consistent with the study by Sajjadifar and Gudarzi Farahani (2009).

Therefore, the results show that all estimated variables have signs consistent with economic theories. Also, all variables are significant at 95% significance level. The Sargan test statistic, which holds the chi-squared distribution with a degree of freedom equal to the over-specified limitations, does not reject the null hypothesis of non-correlated errors or instrumental variables, and thus the validity of the instruments is confirmed .The AR (1) and AR (2) have the null hypothesis of non-Auto correlation. As the above evidence shows, the test results reject the existence of correlation.

Conclusions and Policy Recommendation:

The realization of economic growth and development, along with maintaining water supply stably for future generations, requires adequate knowledge of the factors affecting demand and water consumption and adopting an effective water management approach. Hence, in the present study, the economic growth, employment and income distribution relation with water consumption was assessed by using two-step GMM estimation. The estimated results indicate that economic growth, employment and unequal distribution of income have a positive impact on water consumption.

In Iran, water recycling can be one of the solutions for the water crisis. This solution can also help to create employment. Other measures that can be taken in order to maximize economic growth along with the minimum water consumption, is funding and participation of people in the investment of developmental projects. As an example, investing in factories with high consumption of water and low productivity can be effective and efficient in this regard and help the national economy.

It is worth noting that policy-makers and planners should also have a comprehensive and integrated management in this regard, and pursue the rural development program and redistribution of income to the benefit of the villagers in order to reduce the gap between the rural and urban regions. Another solution that can turn this challenge into an opportunity is to change the structure of the business so that it creates a different atmosphere by utilizing science and technology. For example, the development of the industry will be accompanied by water efficiency, also instead of removing rainwater from the city at high cost, we could store and refine water, which can be effective in job creation.

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