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The Relationship between Virtual Water Exports and the Country's Water Resources Inventory

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Abstract

The imbalance between water supply and demand in the country has challenged water resource management, especially in the agricultural sector. The virtual water study approach, as an approach that values the use of water inputs in the production and consumption of various commodities, has been established and discussed for almost two decades. Based on this concept, the issue of virtual water trade has become important, and countries are interested in knowing how much water they export or how much they import in the trade of agricultural and industrial goods. In this regard, the international trade in agricultural products and the displacement of water contained in them, known as virtual water exports, can be one of the solutions for water resources management. In this paper, it has been studied the relationship between the country's virtual water export and water resources inventory of the country for the period of 2006-2013 using the generalized method of moments (GMM) method. Results showed that virtual water exports had a significant positive relationship with the inventory of water resources, GDP, and population.

Keywords: Generalized Method of Moment (GMM), Gross Domestic Production (GDP), Population, Sargan Test, Virtual Water Exports, Water Resource Inventory.

JEL Classification: Q1, Q3, F2.

1. Introduction

Water has always had a considerable place among various production resources. So that it is considered to be the main source of agricultural production. The importance of this input in Iran is because of water resources constraints, on the one hand, and irrigation inefficiency and

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waste of a large part of water resources, on the other hand. So, it is necessary to study, evaluate, and assess the status of the water use, and the extent to which this input is optimally used, and also to find solutions to increase the supply rate and consumption efficiency of it. Of course, the question of efficiency of the production inputs use can be studied from both the physical and economic terms. The statistics show that Iran consumes water in the agricultural sector 22 percent more than the global scale. In fact, 92 percent of the water used in the country is related to the agricultural sector. Hence, the most important aspect of studying the water economy, is in agricultural sector. The low productivity of water in the agricultural sector indicates the necessity of increasing water use efficiency in this sector. The occurrence of droughts in many areas shows the need for greater attention to water productivity and maximum efficiency of water used in the agricultural sector. In addition to increasing the efficiency in the transfer of water resources and irrigation at the level of farms and gardens, agricultural production with higher economic value and lower water consumption, is considered as the most important project in the water and agriculture sectors. Also, about 90 percent of the water is used in the agricultural sector, and the optimal use of water in the agricultural sector is about 35 percent; while in other countries it reaches 60 percent (KolsomiIsak and Salehnia, 2009).

Water scarcity in many parts of the planet has created many problems for providing safe drinking water, agricultural production, and the overall general human life cycle, such that it is expected that by the year 2025, about 50-60 percent of the world’s population are faced with water stress and dehydration problems. Iran, which is a part of semi-arid areas, is no exception (Ehsani et al., 2008). The issue of imbalance between water supply and demand in the country, has complicated the management of water resources. Water resources management, its development and under its own terms of scope, is faced with the restrictions that have never been raised before.Given the population growth, the growth of the agricultural sector and the urbanization expansion, the depletion of groundwater resources in many areas, has exceeded the limit. The final cost of water supply, and water resources pollution has been accelerated. Therefore, balancing the water supply and demand in different climatic and geographical conditions with the evolving needs of different regions of the country cannot simply reduce or compensate for the problems just by reliance on supply management and new installations and hardware aspects (the performance report of the Ministry of Energy of 2005).

As a result, one of the issues which taken into consideration in the world over the last decade is virtual water trade. The virtual water trade approach, as an approach to water input in the production and consumption of various commodities, has been introduced and discussed for almost two decades. This approach studies that how much water is used for goods' production or consumption. According to this concept, the issue of virtual water trade has become important, and countries are interested in the topic to know how much water they export or how much they import in agricultural and industrial goods trade. Also, how much do they depend on the water in their country to provide food security and production of domestic goods? Thus, in response to the above question, virtual water trade was adopted as one of the water resource management approaches, and in many countries, studies were conducted to calculate the amount of virtual water in producing commercial goods. Therefore, the present study was conducted to investigate and analyze the domestic studies and experiences of other countries, in order to study the role of virtual water trade in water resources management. It also determines how much of countries' water resources is transferred virtually through trade. In other words, how much does virtual water trade play a role in water resource management, and what can be expected from it?

The remainder of this paper is organized as follows. Section 2presents the theoretical foundations including the theories and the empirical studies' findings. Section 3 introduces the research method and the tests used, andSection 4 explains the test results and model estimation. Section5 summarizes and concludes the paper.

2. Literature Review

Virtual water was first defined by Allen in 1993. It is the amount of water available in the global system through the agricultural commodities exchange. Also, according to him, it is the amount of water in the cereals, milk, and animal products based on the amount of water needed for their production. Then, this concept was introduced as an economic tool for reducing water scarcity problems at the national economies level (Mohammadjani and Yazdanian, 2014).

The use of virtual water trade approach as one of the methods of water resources management, is accepted and emphasized by most researchers, and they have presented various solutions to achieve it. Also, it is necessary to pay attention to its effectiveness in order to prevent water crisis. So, an economic optimization of the virtual water trade or the balance between the export and import of virtual water, needs to be made with a view to maintaining the level of goods and services producers' income, environmental issues, and social issues, so as to increase the effectiveness of this tool in controlling water resources crisis. Today, water scarcity has led to lots of problems in providing safe drinking water, adequate crop production, and the general trend of human life. According to international statistics, it is expected that by the year 2025, at least half of the world's population is faced with water stress, and drought-related problems. This problem is more serious in countries in the dry and semi-arid including Iran. Iran has about one-third of annual global rainfall, and about three times of the world's average annual evaporation. Also, rainfall distribution is very heterogeneous, and mostly mountainous regions are rainy. So, there is no adaption between periods of rainfall with periods of agricultural production in the plains. Hence, it is necessary to use various means to prevent the crisis in the country's water resources.

2.1 The Relationship between the Concept of Virtual Water and Water Productivity

Given the fact that water is used as the primary input in production, the water consumption will be different based on the of production technology type. Some technologies are water-consuming, and others are water-storing. If water production technology is of water-consuming structure, water use will increase and water productivity will decrease (Ehsani et al., 2003). Because the production technology has mechanical/technical identity in industrial production, the water productivity rate, and therefore, the demand for it can be managed. But in producing the agricultural products, the rate of water use (water demand) is not much controllable and manageable due to the existence of a biological structure (in addition to the technical nature) in the production technology. In other words, using advanced irrigation systems, despite improving water productivity, does not necessarily reduce overall consumption. The use of irrigation technologies has two effects. On the one hand, increasing the irrigation efficiency can cause water saving, and on the other hand, make it possible to use the same water source to produce more products. In other words, productivity is improved, but the absolute level of water use remains unchanged. In fact, farmers cultivate other lands with an incentive to increase their income, which before that did not have the advantage of cultivation. But with additional water, it will be possible for them to do this. As a result, along with productivity, there is a need for a new concept for the economic use of water, which is referred to as virtual water. Water productivity shows the production amount per unit of water consumption, which represents the medium production concept, but is reversely correlated with virtual water concept. Because virtual water is actually the water amount used per unit of product, and the emphasis of virtual water concept is on the water amount used in the production process. In Figure 1, the inverse relationship between these two concepts is illustrated.

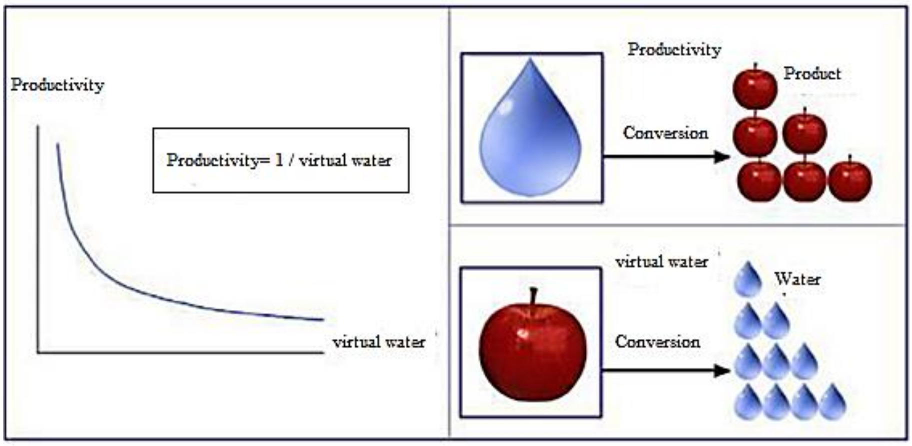

Figure 1: The Relationship between Virtual Water and Productivity.
Source: Portal of Water Consumption Management, Water and Wastewater Engineering Company of Iran.

2.2 Two Views on Virtual Water

Based on the international trade theory, the business two sides can benefit from business by applying the relative advantage principle. This principle can also be used in case of water inputs. If an area has the comparative advantage of water resources, it can produce water-consuming products, and exchange with another areas, which do not have any advantage. But it should be noted that there are two general viewpoints on virtual water trading. In the first one, virtual water trade can be an appropriate substitute for transfers between water basins in countries. Accordingly, instead of investing in the water physical transfer, it can be imported or exported virtually, which is cheaper than investing in large-scale projects for the transfer between water basins. In the theory of virtual water trade, in order to reduce the pressure on water resources, low water counties are recommended to import food instead of producing food from domestic water sources, and allocate domestic water resources for lucrative business activities. In fact, the option of virtual water trade through the agricultural goods exchange, both domestic and foreign, is a solution that can be used to prevent water crisis, and scarcity at the national, regional, and global levels, and prevent its negative economic, social, and political consequences.

In the second viewpoint, relative self-sufficiency and investment in food security, have been given priority over virtual water trade. Because virtual water trade, ignores the future economic situation of farmers, and does not take into account farmers' income dependence on agriculture. On the other hand, the problems made by the unemployment of a part of society, are more than the benefits of virtual water trade. Therefore, one of the requirements for using virtual water trading tools to manage water resources, is to take into account both the above-mentioned advices. For example, if it is decided to replace imports instead of production for a given product based on the first approach, it should be surely planned to create alternative employment or to propose an alternative product with low water consumption.

2.3 Research Background

Mohammadjani and Yazdanian (2014) suggested that Iran is currently in a severe water crisis, and given the constant availability of water resources, population growth, and insufficient attention to water resources management—in the absence of proper and timely policies in the water resources management in both supply and demand dimensions—the intensification of unfavorable status of water resources in the country, affecting security, and economic indicators, will be unavoidable. Therefore, improvement of water demand management, especially in agriculture, through observing the national–regional optimal cultivation pattern, paying more attention to the "virtual water" index in explaining the production pattern, and agricultural products trade, as well as considering the economic value of water, are requirements to face the water crisis, which should be considered by planners in the country.

Gholamhosseinpoor et al. (2013) studied the investigation of water ecological footprints, and virtual water indicators in pistachio and date products in Kerman province, and found that the problem of water and rainfall shortage, is an important and non-deniable reality in Kerman province. The total water consumption within a country by its own, is not a proper indicator for the actual use of water from global water resources. Water ecological footprint is an indicator for determining the water actual consumption. As a result, the study of water ecological footprints, and strategic products indicators for virtual water, can be useful for policymaking, and optimal water resources planning. The water ecological footprint of the province in Kerman, was estimated to be 5.56 billion cubic meters in agriculture, which is annually 2097.2 cubic meters per person. Kerman province is the exporter of virtual water, and the province's dependence on foreign water resources, is very low. The water deficit index or water use intensity in agriculture sector, was estimated to be 123.3 percent of the province's renewable water resources, which according to the United Nations Commission on Sustainable Development, if the volume of water consumption in the percentage of total renewable water is annual, that country is accounted for having low water. Thus, Kerman is considered to have water deficit. Therefore, reducing pressure on domestic water resources, requires more utilization of the virtual water exchange strategy in importing high water products to the province.

Razavi and Davari (2013) studied the role of virtual water in water resources management, and came to the conclusion that in recent years, the planet climate changes, and the occurrence of droughts, and on the other hand, the increase in the world’s population, had led to problems for human beings in supplying water and food. Water crisis is more serious in countries like Iran, which has a dry and semi-arid climate. In fact, given the existing resources and current demand, water resources will not be able to meet future needs. As a result, it is essential to pay attention to the new ways of providing water. One of the most common ways in the world, is to attach importance to virtual water and its trade.

Lenzen et al. (2012) undertook a joint analysis of “water scarcity” and “virtual water trade” in different countries, and showed that the virtual water trade could be a solution to water crisis in each country.

Verma et al. (2008) estimated the flow of virtual water from product exchanges in various Indian states during the 1997–2001 period, which was more than 106 billion cubic meters or 13 percent of the total volume of water consumed in that country. Of course, it should also be noted that importing food for the purpose of using virtual water exchange, also affects the economic, social and environmental sectors of a country, and is directly related to the food security and culture of the country. Therefore, it is imperative for underwater countries to find the optimum spot for virtual import of water considering their conditions, capacities and needs, as well as their food security considerations. Most experts treat international food products’ exchange as one of the key solutions in controlling global water consumption.

Van Oel et al. (2008) suggested that water footprint consisted of two components: Blue water footprint and green water footprint. Blue water footprint is the volume of water consumed from global blue water resources (running water in rivers, underground water, etc.) for producing goods and services consumed by people. Green water footprint is the volume of water evaporated from global green water resources (rain stored in soil as soil moisture).

In line with previous studies, this paper examines the economic relationship between virtual water exports, and Iran’s water resources inventory according to Arellano and Bond (1991), which uses a two-step generalized method of moments (GMM) for dynamic panel data.

GMM was first introduced by Hansen in 1982, and then was expanded by Chamberlain (1987), and Newey (1988). This model is applicable to time series, cross-sectional, and panel data. Hayashi and Sims (1983), Stoica, Soderstrom and Friedlander (1985), Hansen and Singleton (1991; 1996), and Hansen, Heaton, and Ogaki (1996) have studied the GMM estimators use in time series. Anderson and Hsiao (1981) took the first major step to remove the special effects of each area (country), and proposed 2SLS model to overcome problems of dynamic combination data equations that led to the unobserved effects of each section (country), and individual effects to be auto-correlated with explanatory variables. But Matyas and Sevestre (1991) regarding the estimation of 2SLS, suggested that this model could result in the coefficients large variances due to the problem of choosing the instruments, and caused the estimates not to be significant in terms of statistics. Anderson and Hsiao proposed a solution for autocorrelation problem, and suggested that either the dependent variable could be used at the level, or the first and second interruptions of this variable could be used as instrumental variable. But according to Arellano in this regard, using an instrumental variable in the level, is preferred rather than its interruptions for having smaller variance. Also, no observation will be lost in using instrumental variable at this level especially if the sections number is high, and the time dimension is small, which is notable for several aspects as another assumption in this regard:

Considering individual heterogeneities and more information and eliminating the biases in cross-sectional regressions, results in more accurate estimates with higher efficiency and lower co-linearity (Arellano and Bond, 1991).

Solving the problem of endogenous institutional variables, is one of the main advantages of the basic estimator of the models proposed by Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1998). Therefore, the GMM method has been proposed in panel data by Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1998) to solve this problem. The advantage of the present research is using Arellano and Bond’s two-stage model over dynamic GMM studies, where all regression variables which are not correlated with error terms (such as intermittent variables and differential variables) can potentially be an instrumental tool (William Greene, 2003).

Reducing the co-linearity problem in the model: Using interrupted dependent variables, eliminates co-linearity in the model. It is very less likely that the interrupted difference, and the institutions' interrupted level be correlated with the interrupted difference, and the variables interrupted level like the others (Nadiri and Timoor Mohammadi, 2011).

The GMM method eliminates many variables that, over a constant time and strong factors, affect the dependent variable, and can be correlated with other variables. These eliminated variables lead to a bias in the model estimation. The GMM allows these factors' impact to be eliminated by differentiation from statistics (Baltagi, 2005).

3. Methodology and Data

This paper tries to estimate the relationship between virtual water export and water resources of Iran, with 15 trading partners including Azerbaijan, Afghanistan, Armenia, the United Arab Emirates, Pakistan, Turkey, Turkmenistan, Tajikistan, Oman, Iraq, Kazakhstan, Qatar, Kuwait, Georgia, Russian Federation, with regard to the priority export share for the period of 2006–2013. Also, the estimation model of GMM in this study, is the trade gravity model by Arellano and Bond (1991). The data have been gathered from World Development Indicators (WDI) database.

$$VWE_{i,j} = f(VWE_{ij,t-1}, VWA_i, GDP_i, GDP_j, POP_i, POP_j, DIS_{ij})$$

$$VWE_{ij,t} = \beta_0 + \beta_1 VWE_{ij,t-1} + \beta_2 VWA_{i.t} + \beta_3 GDP_{i.t} + \beta_4 GDP_{j,t} + \beta_5 POP_{i,t} + \beta_6 POP_{j,t} + \beta_7 DIS_{ij,t} + v_{i,t}$$

Where:

VWEij: virtual water export from Iran to country j (cubic meter)

VWAi: water resource inventory in Iran (million cubic meters)

GDPi: gross domestic production per capita in Iran (ppp the base year is 2011)

GDPj: gross domestic production per capita of country j (ppp the base year is 2011)

POPi: population of Iran

POPj: Population of country j

DIS: distance between the two countries (km)

According to the classic gravity model, the volume of trade exchanges between the two countries is a function of income (GDP), population and the distance between the two countries. In this model, the variable population of countries expresses the ability to attract domestic markets. As the countries' population increases, their domestic market has the potential to attract more products from abroad. On the other hand, a higher population leads to more production, and because of the scale economics, products are offered to the world's markets at lower prices, which increases the country's exports due to the relative advantage. Due to the groundwater aquifers in a country, the higher is the water inventory, the greater will be the production, and the more will be the exports. Therefore, in the model's final estimation, the ratio of per capita GDP in Iran to per capita GDP of partner countries, and the ratio of the Iran's population to the population of partner countries has been calculated.

In order to calculate virtual water export, the total amount for each product to each country, is first obtained in kg, by the annual statistics of the Customs Office. Then, by using the coefficient of virtual water content of each product, the amount of exported virtual water of the same product is acquired, and finally, the amount of exported virtual water of different types of products for each country is obtained.

$$VWE_{cn} = VWC \times E_{c,n}$$

VWEcn: Virtual Water Exports of product c in year n

VWC: The amount of virtual water of product c

$E_{c,n}$: annual export value of product c in year n

This studyproducts to calculate virtual water exports are as follows: grape, rice, pistachio, onions, dates, cucumbers, oily seeds, barley, sugar beet, apples, potatoes, tomatoes, wheat, walnuts, beans, citrus, chickpeas, sugar cane, and watermelon. The reason for selecting them is their high coefficient of virtual water.

Table 1: The Amount of Virtual Water Exports for Grape in each Importing Country

Countries	Exports (kg)	Virtual Water (m^3.kg)	Virtual Water Exports (m^3)
Azerbaijan	4034440	.84	3388929.6
Armenia	1088756	.84	914555.04
Afghanistan	381156	.84	320171.04
the United Arab Emirates	30361978	.84	25504062
Pakistan	7302444	.84	6134053
Tajikistan	14221	.84	11945.64
Turkmenistan	150923	.84	126775.32
Turkey	4529527	.84	3804808.7
Iraq	15184016	.84	12754573
Oman	0	.84	0
Qatar	210343	.84	176688.12
Kazakhstan	28415	.84	23868.6
Russian Federation	42711930	.84	35878021
Kuwait	655887	.84	550945.08
Georgia	747870	.84	628210.8

4. Empirical Results

4.1 Unit Root Tests in Panel Data

Before performing the panel cointegration test to determine the long-term relationship between the main indexes of the study, unit root test should be carried out to prevent variables'false regression. The econometric, and unit root studies suggest that the unit root test based on panel data, is more reliable than the unit root test based on time series. In this paper, IPS unit root test, augmented Dickey-Fuller test (ADF), and unit root tests of Levin, et al. (2002) will be used for investigating the variables' reliability. The table results, the statistics amounts estimation, and their acceptance probability, show that only virtual water exports are in a reliable level, and the water inventory and GDP have been stabilized with a one-time difference. Results can be presented to enthusiasts.

4.2 Panel Cointegration Tests

The most important thing in cointegration analysis is that, despite the static time series and a random increase or decrease in the long term, it is possible that a linear combination of these variables be always static, and with no trend. The long-term relationships are discovered by using cointegration analysis. In other words, if every economic theory is correct, and there is a relationship in the variables set, we expect that the combination of these variables on the long-standing, become static and without a trend. As in time series, analyzing the variables in the panel data cointegration is also important. Cointegration tests have more credibility and authority than each level of panel cointegration tests individually. The tests can also be used even when the sample size is small, and the period is short. [24]

The panel data cointegration tests are as follows:

$$\begin{cases} H_0 : \rho = 1 \\ H_1 : \rho \langle 1 \end{cases}$$

The null hypothesis suggests a lack of cointegration between all levels, while the hypothesis shows the variables' integration.

In this study, we use both t-panel test type Phillips–Perron (PP-Statistic Panel), and Statistic panels test type augmented Dickey–Fuller showed by Statistic Panel ADF. Group Phillips–Perron test statistics type P (Group PP-Statistic), and group Dickey–Fuller test (Group ADF-Statistic) have been used to analyze the presence or absence of cointegration relationships among the variables.

Table 2: Panel Data Cointegration Test Results

Test Statistics	Statistic	Prob.
Panel v-Statistic	-3.019199	.9987
Panel rho-Statistic	1.537790	.9380
Panel PP-Statistic	-11.49592	.0000
Panel ADF-Statistic	-5.692166	.0000
Group rho-Statistic	3.959387	1.0000
Group PP-Statistic	-7.623379	.0000
Group ADF-Statistic	-2.821335	.0024

It is noticeable that, according to the results of Table 2 and given the significance level of lower than 95 percent, the null hypothesis of the cointegration relation absence between the variables can be denied, and of the seven tests, four tests testify to the convergence and variables' existence are cointegrated in the long-run, and there is a long-term relationship between them.

4.3 Model Estimation and Results Interpretation

Table 3: GMM Results for the Model

Variable	Coefficient	t-Statistic	Prob.
VWE(-1)	-.247377	-164.2672	0.0000
VWA	3369.217	34.51534	0.0000
GDP	0.090840	11.79875	0.0000
POP	2.07E-08	8.923532	0.0000
J-Statistic=12.66595Instrument Rank= 15			
Sargan- Test= 0.315718			

The results of the gravity model estimation for Iran's partner countries using GMM show that the variables coefficients are meaningful, their signs are as expected, and compatible with the theoretical foundations of the subject. Estimated relationships represent the positive effects of the variables of Iran's water resources inventory, Iran's GDP per capita compared to partner countries, Iran's population in relation to partner countries, and due to the fact that geographic distance and distance are constant over time, this variable is removed from the original model.

Due to the spider tale, which states that supply is the function of the price of a year ago, but demand is the function of this year price, the negative significant coefficient of the dependent variable interruption in the model, can be considered as a reason for the unstable trend of our country's agricultural exports. Each year the export of agricultural products in the country is high, and their prices increase, they encourage farmers to grow that product more in the following year, but the instability of the agricultural export market (due to nonscientific marketing, political issues, etc.) has led to surplus supply in the global markets, and in any case reduces the export of the same products in the year or years to come. The countries GDP reflects their economic size as well as their production capacity. The larger is the size of an economy and its production capacities, the greater will be the possibility of producing at a lower cost, and this will increase the export of that country. On the other hand, this will cause the domestic market to absorb foreign products, and so it causes the foreign trade to grow. Moreover, the positive significant coefficient of the country's GDP output confirms that. The rise in the population of the exporting country and the importing countries' also has the same action mechanism.

Increasing the country's water inventory and encouraging farmers to produce more, along with increasing population and the increasing need for more food, will create large international markets for food, increase the national products export, and ultimately increase virtual water exports. Additionally, the Sargan test's confidence level, indicates that the instrumental variables are not correlated with error terms.

4.4 Sargan Test

Sargan test statistic has been supported by Arrelano and Bond (1991), Arrelano and Bover (1995), and Blondel and Bond (1998). Sargan test is used to analyze the validity of instrumental variables defined in the model, and due to being too specific equation, is defined as follows:

$$s = \hat{\Sigma}' Z \left(\sum_{i=1}^{N} Z_i' H_i Z_i \right)^{-1} Z' \hat{\Sigma}$$

In this case, $\hat{\Sigma} = y - x\hat{\sigma}$ and $\hat{\sigma}$, matrices of $K \times 1$ are the estimated coefficients, Z is instrumental variable matrix, H is a matrix with dimensions (T-q-1), T is the observations number, and q is the number of explanatory variables. We examined two hypotheses to define the instrumental variables validity:

$$H_0 = m(\theta_0) = 0$$
$$H_1 = m(\theta) \neq 0$$

In Sargan test, H_0 determines the correlation between the instrumental variables and disturbing element, and is based on the authentic model. Alternative hypothesis (H_1) is based on the invalidity model. Sargan test asymptotically follows the distribution of with freedom degree as k-q, where k equals the number of instrumental variables, and q is equal to the explanatory variables number. To confirm Sargan test in 95 percent of testing level, calculations with degrees of freedom k-q, is compared with of the Table 3. If calculated is less than table, then H_0 is accepted (variable to obtain the freedom degrees of table detract rated instrumental number of variables from the estimated variables' number in the model).

Results for model show the acceptance of the null hypothesis and there is no correlation between the instrumental variable and disturbing elements.

5. Conclusion

Due to worsening water scarcity crisis in various countries of the world, including Iran, the issue of virtual water and its trade has become of particular importance in future planning and water macro-policy. Hence, it is calculated the amount of imported or exported water as commercial virtual water, as well as studying the statistics of export and import of goods and food products, especially agricultural products among different countries of the world, as well as Iran. Increasing the competition for water, the need for food for a growing population, and increasing water scarcity in many parts of the world, including Iran, are some of the important reasons that make vital the need for comprehensive integrated forward-looking management water resources.

Hence, for a country like Iran, preventing the transfer of virtual water contained in the traded products, is a major portion of water resources management. This can increase the actual water supply, and reduce the pressure on water resources. Considering the policy of developing non-oil exports, along with attention to the concept of virtual water, causes to have a more realistic view toward agricultural production, the opportunity cost, and the benefits from their production, and to set national goals in a way as to maximize the long-term benefits of the community in terms of efficiency in production and consumption of national resources. Iran is currently exporting virtual water. According to our results, it is expected that along with population growth and GDP growth, this process will continue and even increase. However, reducing precipitation, and consequently reducing the country's water supply in recent years, can be a deterrent. The present study is to correct the perceived "underestimating the country's water scarcity problem", which has been formed by most farmers and policymakers of the country, due to the experience of last years of high water and seasonal rainfall. It should be noted that agriculture in Iran is somehow a family occupation, and the product type and likely irrigation methods are chosen based on the experience. In other words, scattered precipitation in some years, as well as access to water resources in some regions of our country, should not be taken into account as a solution to the problem of water deficit across the country. Therefore, policies for the production and export of less-watered agricultural products must be made, due to the acute water problems throughout the country over time.

In addition, the most important issue is policymaking for agricultural production and exports. The question is that if in Iran, agricultural production and exports are done either based on a scientific policy or according to the traditional climatic and regional conditions.

This is the reason for the lack of optimal management of water resources in our country. In this regard, measures that can be considered are: modifying the pattern of agricultural water consumption by training farmers, promoting culture and awareness of farmers in order not to use traditional irrigation methods in the country, and making macro policies in the country to prevent the export of water-embedded products, and substituting them by imports. One of the options for reforming the regional system is production by cultivating products that require less water, rather than the products with high water requirements, especially in water scarce areas. In order to increase water consumption efficiency in specific areas, products with lower water productivity should be replaced by products with a higher water productivity. Thus, water is saved for products with higher economic value, as well as for other indigenous expenditures. It is also necessary to modify the structure of agricultural exports by reducing the production and export of products that require abundant water, and have little economic value on world markets, and by replacing them with similar imported products.

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