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Consideration the Effects of Water Sector Investment In Economic Development in Iran

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Abstract
Energy is one of the most important influential factors on economic growth. Water is one of the main inputs for many other sectors. In this study, in order to see the effects of water sector investment from production function, we use economic time series database of national accounts in central bank, vice-presidency for strategic planning and supervision, and Iran water resources management co., which were gathered during 1980-2010. As economic growth and different sectors value added (agriculture, industry and mine, services, and petroleum sectors) variables used in empirical analysis was integrated of order one, employed Granger causality test. Results show for different sectors (agriculture, industry and mine, services, and petroleum sectors) in Iranian economy implies that the elasticity of water investment in agricultural sector is significant, and positive, and for the rest of the other sectors is non-significant. Also results show that in the short-run and long run, the Granger causality runs from economic growth to water resource investment and vice versa in Iran.
Key words: water investment, economic development, cointegration;

1. Introduction

World economies are so divergent and hypogenous yet, each seeks for growth and development, because of advantages and benefits which is realized in this process. However, to attain a sustainable, high economic growth we should answer to the question that what factors determine the rate of economic growth? Or how and by means of what factors and policies the rate of economic growth can be influenced? Among many different factors which were effective in economic growth and development in Iran, water industry is crucial for its considerable achievements.

Water as a renewable resource and as a natural, economical, social and environmental commodity plays an exclusive role in economic growth. The first reason for expansion of water industry in Iran is exploiting its economical benefits. Regarding its importance in development of real sectors of the economy and its basic role in production and distribution process, water sector has a certain place in development plans of the country. Of the whole renewable, available waters (130 billion m^3) approximately 105 billion m^3 are surface flows, and the rest (25 billion m^3) penetrating flows as groundwater. There are 130 billion m^3 of water which can be extracted, however only 84% of it is used for agricultural applications in about 30% efficiency and the rest of the allocated water (70%) is wasted during transportation and consumption stages (Ettehad, 2002). These information show that this industry faced restrictions to exploit available resources in water sector. By recognizing these restrictions, and by fundamental research in every single ancillary activities of water industry, we will be able to use them for obtaining benefits in the industry.

In early civilizations, water played a relatively simple role. It was needed for transportation and drinking and it provided a fishing and hunting source. Overtime, sedentary agricultural societies evolved and water use became more important. Families began settling near springs, lakes and rivers to supply livestock and crops with water, gradually developing technologies to divert water for irrigation and domestic purposes. Babylonian, Egyptian, Hittite, Greek, Etruscan, Roman, Chinese, Mayan, Incan and other empires constructed water delivery systems such as long aqueducts to carry water to large cities.[19] In fact, until the middle of the twentieth century, most societies were able to meet their growing water needs by capturing reliable and relatively inexpensive sources.

When water is plentiful relative to demand, water policies, rules and laws tend to be simple and only casually enforced. As populations grow and economies expand, water sectors evolve from an "expansionary" phase to a "mature" phase. At a certain point during the expansionary phase, the financial and environmental costs of developing new water supplies begin to exceed the economic benefits in the least productive (marginal) uses of existing supplies. The real location of existing supplies, rather than the capture of unclaimed supplies, then becomes the least costly method to maximize benefits.

A water sector in the "mature" phase is characterized by rising marginal costs of providing water and increasing interdependencies among users. In this phase, conflicts over scarcities and external costs arise. (External costs result when one user interferes with another's supply, e.g. when an upstream user pollutes a river and raises costs for downstream users.) These conflicts eventually become so complex that elaborate management systems are needed to resolve disputes and allocate water among different users and economic sectors.

Economic policy-makers tend to confront policy issues one at a time, stating policy objectives in single dimensional terms. This approach presents difficulties because a policy aimed at achieving a single objective usually has unintended and unrecognized consequences. Water managers and policy-makers need to assess the entire range of government interventions to understand fully the economic, social and environmental impacts on a given sector, region or group of people.

Improving water resource management requires recognizing how the overall water sector is linked to the national economy. Equally important is understanding how alternative economic policy instruments influence water use across different economic sectors as well as between local, regional and national levels and among households, farms and firms. For too long, many water managers have failed to recognize the connection between macroeconomic policies and their impact on, for example, technical areas such as irrigation.

Macroeconomic policies and sectoral policies that are not aimed specifically at the water sector can have a strategic impact on resource allocation and aggregate demand in the economy. A country's overall development strategy and use of macroeconomic policies - including fiscal, monetary and trade policies -directly and indirectly affect demand and investment in water-related activities. The most obvious example is government expenditures (fiscal policy) on irrigation, flood control or dams.

This study is an attempt to do a research work in water industry of the country focused on the effects of water sector investment in economic development of Iran. The paper is organized as follows: In Section 2 we provide a literature review about this topic. Econometric Methodology and Empirical results are provided in Section 3 and Section 4. Final section contains the conclusions.

2. Experimental literature review

Many studies have been done in this part which is an infrastructure component of economic studies. There are a large number of papers examining the empirical relationships between energy consumption and economic growth. Empirical literature on the relationship between energy consumption and economic growth can be divided into two time periods: the short run and the long run. Also, the results of the studies can be divided into four considerable categories: first of them is unidirectional causality running from energy consumption to economic growth; another of them are unidirectional causality running from economic growth to energy consumption; the third of this categories is bidirectional causality between energy consumption and output growth; and finally, no statistically significant link between these two variables (Das et al, 2012).

Misheal (2005) in his study during 1966-2005 in OECD countries and the U.S. named "the effects of state's costs on economic growth" explained theoretical topics and reviewed international practical documents in countries decreased state's costs as a portion of national production drastically, and analysed these reforms. By comparing developed countries to some American countries, he resulted that controlling costs would led to success of the countries and in this way the rate of economic growth accelerated.

Sulmaz Moslehi (2004) estimates optimum size of state and its effects on growth in 2001-2002. She generalized the Barrow's model for oil-producing countries and concluded that total indicator for disorders due to policymaking, arrangements and lack of effectiveness of state's activities on economic growth is significant and negative. Barrow's theory in the frame of a non-linear model is confirmed and in a linear model, both of consumption and construction costs have a negative effect on growth. She also separated consumption costs into hygiene and education costs and reached to a positive and significant relation to growth, however other consumption costs conversely related to economic growth (other than hygiene and education).

Fereshteh Chalak (2007) in her study named "Dynamic analysis of state costs' effect on Iran economic growth" during 1997-2004 also addressed the issue. By using dynamic system method, she simulates macro variables and explored the effects of consumption and construction costs of the state on economic growth and other variables. First of all, by assuming 40% increase in government budget in ten-year periods in three different scenarios, she studied state's cost on economic growth and compared impact rate of consumption and construction costs of the state. Results show that although an increase in construction and consumption costs of the state lead to an increase in economic growth, this impact is greater for construction costs. It is also showed that financing the state by banknote printing would decrease the economic growth.

Another study named "water role in developing agriculture sector" is that of Hamid Reza Khalil Ababdi and Hamid Abrishami (2004), both scholars of University of Tehran. The results of this study show that water sector is a fundamental and basic one which can be employed as a growth engine in economy. It can lead to growth of other sectors, especially agricultural sector, and its subordinate activities so that every unit investment (one million Rails in the price of the year 1998) on water sector would lead to both direct and indirect employment for 0.29 persons. Calculation of backward and forward linkage also showed that water sector is ranked eleventh in terms of backward linkage and that of forward linkage is ranked sixth.

A study was done by "T. H." (2008) in headquarters of water administration of ministry of public affairs, named "Correlation between Investment in the Water Sector and Economic Growth of Developing Countries" consists of analyzing around both relationship between rainfall and economic growth and that of investment in water sector and economic development. Standard deviation analysis of time series in 22 African developing countries consists of rainfall, national budget in financing water and hygiene sector, official development aids for all economic sectors, official development aids in infrastructures of water and GDP per capita. The analyses show that there is no significant relationship between deviation from mean rainfall and GDP per capita, and the reason must be sought in historical, social, political and economical backgrounds. In all 22 African countries, there were also a linear significant relationship between national budget in financing water and hygiene sector and GDP per capita. Likewise, in 17 out of 22 African countries there were a significant relationship between development aids for all sectors and GDP per capita. Meanwhile, in 16 African countries out of 22 in linear egression, there were no significant relationship between official aids for water infrastructures and GDP per capita. However, it showed a linear significant relationship between financing water and hygiene sector and GDP per capita in all 22 African countries, and national budget in financing water and hygiene sector had a multifold impact on GDP per capita in comparison to official development aids.

3. Econometric Methodology

In this part, the effect of water investment on different economic sectors in the form of a full logarithmic equation for years 1980 to 2010 is explored also this paper consider the effect of water resource investment on economic growth in Iran. The model used in this estimation is time series data and Panel Data model which is assessed using Fixed Effect method. The reason why we use Fixed Effects method is that the number of cross-sections (economic sectors) in this model is less than estimated coefficients therefore Panel Data model cannot be estimated by using Random Effect method and Hausman testing is not relevant in this case. The results of estimates done on the basis of economic growth for each sector are as followed:

3.1. Cointegration – ARDL-Bounds Testing Procedure

In this regard, by applying the model suggested by Odhiambo, 2010 the recently developed Autoregressive Distributed Lag (ARDL)-Bounds testing approach is used to examine the long-run relationship between oil consumption and economic growth. The ARDL modelling approach was originally introduced by Pesaran and Shin (1999) and later extended by Pesaran et al. (2001).

$$\Delta lnWRI_t = \beta_0 + \sum_{i=1}^{n} \beta_{1i} \Delta Ln\ WRI_{t-i} + \sum_{i=0}^{n} \beta_{2i} \Delta Ln\ Y_{t-i} + \beta_3 Ln\ WRI_{t-1} + \beta_4 Ln\ Y_{t-1} + \mu_t \quad (1)$$

$$\Delta lnY_t = \delta_0 + \sum_{i=1}^{n} \delta_{1i} \Delta Ln\ Y_{t-i} + \sum_{i=0}^{n} \delta_{2i} \Delta Ln\ WRI_{t-i} + \delta_3 Ln\ Y_{t-1} + \delta_4 Ln\ WRI_{t-1} + \mu_t \quad (2)$$

Where: $InWRI$ = log of water resource investment; $In\ y/N$ = the log of real per capita income; μ = white noise error term; Δ = first difference operator. The bounds testing procedure is based on the joint F-statistic (or Wald statistic) for cointegration analysis. The asymptotic distribution of the F- statistic is non-standard under the null hypothesis of no cointegration between examined variables. Pesaran and Pesaran (1997) and Pesaran et al. (2001) report two sets of critical values for a given significance level. One set of critical values assumes that all variables included in the ARDL model are I(0), while the other is calculated on the assumption that the variables are I(1). If the computed test statistic exceeds the upper critical bounds value, then the H_0 hypothesis is rejected. If the F-statistic falls into the bounds then the cointegration test becomes inconclusive. If the F-statistic is lower than the lower bounds value, then the null hypothesis of no cointegration cannot be rejected (Odhiambo, 2010).

3.2. Granger Non-Causality Test

The existence of cointegration relationships indicates that there are long-run relationships among the variables, and thereby Granger causality among them in at least one direction. The ECM was introduced by Sargan (1964), and later popularized by Engle and Granger (1981). It is used for correcting disequilibrium and testing for long and short run causality among cointegrated variables. The ECM used in this paper is specified as follows:

$$\Delta lnY_t = \delta_0 + \sum_{i=1}^{n} \delta_{1i} \Delta Ln\ Y_{t-i} + \sum_{i=0}^{n} \delta_{2i} \Delta Ln\ WRI_{t-i} + ECM_{t-i} + \mu_i \quad (3)$$

$$ln\ WRI_t = \beta_0 + \sum_{i=1}^{n} \beta_{1i} \Delta Ln\ WRI_{t-i} + \sum_{i=0}^{n} \beta_{2i} \Delta Ln\ Y_{t-i} + ECM_{t-i} + \mu_i \quad (4)$$

Where ECM_{t-i} = the lagged error-correction term obtained from the long-run equilibrium relationship. Although the existence of a long-run relationship between WRI and y/N suggests that there must be Granger-causality in at least one direction, it does not indicate the direction of temporal causality between the variables. The direction of the causality in this case can only be determined by the F-statistic and the lagged error-correction term. It should, however, be noted that even though the error-correction term has been incorporated in all the equations (3) – (4), only equations where the null hypothesis of no cointegration is rejected will be estimated with an error-correction term (Odhiambo, 2010).

3.3. ADF Unit Root Test

Nelson and Plosser (1982) argue that almost all macroeconomic time series typically have a unit root. Thus, by taking first differences the null hypothesis of nonstationarity is rejected for most of the variables. Unit root tests are important in examining the stationarity of a time series because nonstationary regressors invalidates many standard empirical results and thus requires special treatment. Granger and Newbold (1974) have found by simulation that the F-statistic calculated from the regression involving the nonstationary time-series data does not follow the Standard distribution. This nonstandard distribution has a substantial rightward shift under the null hypothesis of no causality.

Thus the significance of the test is overstated and a spurious result is obtained. The presence of a stochastic trend is determined by testing the presence of unit roots in time series data. Non-stationarity or the presence of a unit root can be tested using the Dickey and Fuller (1981) tests.

The test is the t statistic on φ in the following regression:

$$\Delta Y_t = \beta_0 + \beta_1.trend + \rho Y_{t-1} + \sum_{i=0}^{\infty} \varphi_i \Delta y_{t-i} + \varepsilon_t \qquad (5)$$

Where Δ is the first-difference operator, ε_t is a stationary random error (Chang, at all, 2001).

3.4. Tests of Cointegration

The cointegration test is based in the methodology developed by Johansen (1991), and Johansen and Juselius (1993). Johansen's method is to test the restrictions imposed by cointegration on the unrestricted variance autoregressive, VAR, involving the series. The mathematical form of a VAR is

$$y_t = \theta_1 y_{t-1} + \cdots + \theta_p y_{t-p} + \vartheta X_t + \varepsilon_t \qquad (6)$$

where y_t is an *n*-vector of non-stationary *I(1)* variables, x_t is a *d*-vector of deterministic variables, $\theta_1, .., \theta_p$ and ϑ are matrices of coefficients to be estimated, and ε_t is a vector of innovations that may be contemporaneously correlated with each other but are uncorrelated with their own lagged values and other right-hand side variables. We can rewrite the VAR as (Eq. (7)):

$$\Delta_{y_t} = \prod_{y_t-1} + \sum_{i=0}^{\infty} \Gamma_i \Delta_{y_t-i} + \beta_{xt} + u_t \qquad (7)$$

Where (Eq. (8))

$$\Pi = \sum A_i - I_t \quad that \ \Gamma_i = -\sum A_j \qquad (8)$$

Granger's representation theorem asserts that if the coefficient matrix n has reduced rank r<n, then there exist *n* x *r* matrices α and β each with rank r such that $\pi = \alpha \beta'$ and $\beta' y_t$ is stationary. Here, *r* is the number of cointegrating relations and each column of β is a cointegrating vector. For *n* endogenous non-stationary variables, there can be from (0) to (*n*-1) linearly independent, cointegrating relations (Yin and Xu, 2003; Aktaş, Cengiz and Yılmaz, Veysel, 2008).

4. Data and empirical results

4.1 Data

The data used in this study consist of annual time series of GDP and water resource investment and different sectors value added (agriculture, industry and mine, services, and petroleum sectors) for Iran 1980 to 2010. Annual time series data were utilized in this study.

4.2 Result of unit Roots and Cointegration Test

The results of the unit root tests for the series of water resource investment and GDP variables are shown in Table 1. The ADF test provides the formal test for unit roots in this study. The p-values corresponding to the ADF values calculated for the two series are larger than 0.05. This indicates that the series of all the variables are non-stationary at 5% level of significance and thus any causal inferences from the two series in levels are invalid.

Table 1. Results of ADF Test for Unit Roots

Variables	Trend and Intercept	first difference	Critical values (5%)	
LWRI	-2.22	-3.98	-3.63	-3.64
LGDP	-2.10	-3.87	-3.57	-3.58

Note: The optimal lags for the ADF tests were selected based on optimising Akaike's information Criteria AIC, using a range of lags. We use the Eviews software to estimate this value.

The analysis of the first differenced variables shows that the ADF test statistics for all the variables are less than the critical values at 5% levels (Table 1). The results show that all the variables are stationary after differencing once, suggesting that all the variables are integrated of order I (1).

As indicated, the basic idea behind cointegration is to test whether a linear combination of two individually non-stationary time series is itself stationary. Given that integration of two series is of the same order, it is necessary to test whether the two series are cointegrated over the sample period. The results of the Johansen cointegration test for the series WRI and GDP are reported in Table 2.

Table 2. Results of Johansen's Cointegration Test

Null Hypotheses	Alternative Hypotheses	Trace Statistic	Critical Value (5%)
H0	H1		
r=0	r=1	21.44	14.26
$r \leq 1$	r=2	0.58	3.84

Source: we use the Eviews software to estimate this value.

The likelihood ratio tests show that the null hypothesis of absence of cointegrating relation (r = 0) can be rejected at 5% level of significance. Thus, we can conclude that water resource investment and GDP are cointegrated in the long run.

4.3 Cointegration Test

The cointegration relationship between [WRI and GDP= y/N] is examined using the ARDL bounds testing procedure. Two steps are used in this procedure. In the first step, the order of lags on the first differenced variables in equations (1) and (2) is obtained from the unrestricted models - using the Akaike Information Criterion (AIC) and the Schwartz- Bayesian Criterion (SBC). The results of the AIC and SBC tests (not reported here) show that while in the case of WRI equation the optimal lag is lag 1, in y/N equation, the optimal lag is lag 3. In the second step, we apply bounds F-test to equations (1) and (2) in order to establish whether there exists no long-run relationship between the variables under study. The results of the bounds test are reported in Table 3.

Table 3: Bounds F-test for Cointegration

Dependent variable	Function			F-test statistic		
$\Delta Iny/N_t$	y/N (WRI)			2.251		
$\Delta InWRI_t$	WRI(y/N)			2.355		
	Asymptotic Critical Values					
	1%		5%		10%	
	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
Pesaran et al (2001), p. 300, table CI(ii) Case II	4.24	5.21	3.89	3.94	2.75	3.28

Source: we use the Eviews software to estimate this value.

If the series of two variables are non-stationary and the linear combination of these two variables is stationary, then the error correction modelling rather than the standard Granger causality test should be employed. Therefore, an ECM was set up to investigate both short-run and long-run causality. In the ECM, first difference of each endogenous variable (GDP and WRI) was regressed on a period lag of the cointegrating equation and lagged first differences of all the endogenous variables in the system, as shown in Eq. (3). The results of error correction model are presented in Table 4.

Table 4. The Result of Error Correction Model

	Lag Lengths	F Statistics	t statistics for ECMt-1
Δ GDP — Δ WRI	m=2 n = 2	4.74	-2.90*
Δ WRI — Δ GDP	m=1 n =1	4.43	-2.36*

Source: we use the Eviews software to estimate this value.

According to results of the Table 4, short-run causality is found to run from economic growth to water resource investment and vice versa. That is, there is bidirectional short-run Granger-causality between economic growth and water resource investment. The coefficient of the ECM is not be significant in Eq. (3) and (4), which indicates that exists bidirectional Granger causality between water resource investment and economic growth in long run.

The effect of investment in water sector on various sectors of agriculture, industry, service, and petroleum has different results as showed in the table below:

Table5. Exploring investment effect of water sector on various economic sectors

Coefficients impacts of water investment on each sector	Various economic sectors
1.295461*	Agriculture
0.103667	Industry
0.587705	Service
2.383143	Petroleum

Source: calculations of the researcher
*indicates significance coefficients in 90% confidence level

As expected, the effect of water investment on agriculture is positive and significant and its elasticity is more than 1 about 1.3% which indicates the high sensitivity of agricultural products to investment in water sector. This means that increasing 1% investment in water sector will increase economic growth in agriculture sector up to 1.3%. Regarding 93% of water consumption is used in agriculture sector, the results are acceptable. Investment effect coefficients in water sector on industry, service, and petroleum are non-significant. The justified coefficient correlation of this model is 0.99 and that of its long-sighted Watson is 2.05 which show the fitness of the model. The calculated result of elasticity is almost consistent with Demetridis and Mines' long term supply production elasticity infrastructures in national level. As the estimated model is full logarithmic, it is expected that this model is static and the graph of correlation test related to residual model confirms it.

5- Conclusion

Due to the low rainfalls and inappropriate distribution of the time and location of it in our country, Iran is among the most arid and semiarid climates of the world. The situation is getting worse due to population growth, expansion of urbanization, development of economic sectors such as agriculture and industry, and ever increasing demand for water. This paper has investigated the ECM model to examine the causal relationship between water resource investment and economic growth in Iran using the annual data covering the period of 1980- 2010. Prior to testing for causality, the ADF test and Johansen maximum likelihood test were used to examine for unit roots and cointegration. Our estimation results indicate in short run and long run that there are bidirectional short-run causality between economic growth and water resource investment. Results verify that both direct and indirect Granger causality does show a long run effect of water resource investment on economic growth. The purpose of this study was to explore the effects of water sector investment on economic development in Iran. Findings of this study are represented as follows:

1. Despite inherent limitations and inappropriate distribution of water in Iran, utilization of this worthy and non-renewable and expensive resource in terms of investment, is in a very low efficiency.
1. Continuation of indiscriminate use of water resources and low efficiency will exacerbate water shortage.
2. The estimated Solo model in the basis of primary neo-classic one for different economic sectors (agriculture, industry, mine, service and petroleum) indicates that elasticity of water investment on agriculture sector is significant and positive, and its value is about 1/3% and is non-significant for the rest of the other sectors.
3. Drinking and agricultural water tariff rates are so low and cannot be substituted by depreciated assets.

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