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Analyzing the Effect of the Water Reduce Subsidies on GDP

Seyed Mahdi Hosseyni [1*] and Javad Shahraki [2]

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Abstract

The objective of this work is to analyze the effects of decrease in water subsidies (increase in the price of the water) on various economic sectors in order to promote the conservation of this resource based on the actual price of water. But over the past decades, various subsidizing methods hold the cost of water down. On the other hand, the indiscriminate use of these resources led the government to impose enormous costs. Determining the economic impact of subsidy reform can be an essential factor in the determination of water price reform scenarios. The methodology that will be used to explore the implications on the economy will be a computable general equilibrium model (CGE), previously designed for an analysis of the direct taxes of the Andalusian economy (Cardenete and Sancho, 2003), but now enhanced and extended to include emissions of pollutants and the introduction of environmental taxes (André, Cardenete and Velázquez, 2005). This model has been further modified to introduce the variations in the water price that this study investigates the effect of water subsidy reform on the economy based on six scenarios using computable general equilibrium model. Results show that by decreasing subsidies, GDP will reduce in all economic sectors. Government can prevent the decrease in production by redistributing incomes.

Keywords:
Water subsidies reform, GDP, Computable general equilibrium model and GAMS

[1] Ph.D Student at University of Sistan and Baluchestan, Iran.
[2] Assistant Professor Economics, University of Sistan and Baluchestan, Iran.
* Corresponding author's email: shseyedmahdi46@gmail.com

INTRODUCTION

That requires policy solutions and recommendations to solve the problem of subsidies. Over the past years, water pricing below the actual prices has had an adverse effect on the economy. Rapid growth of water consumption, reduced performance, cost subsidy burden on the government budget, and the indiscriminate use of water are some consequences of this policy.

The problem of water shortages in Iran in years of drought and the intense competition for this resource are well known. However, water consumption by the productive sectors in the country appears not to be rational because the Iranian economy has an intensive water consumption production system. This phenomenon is due to many factors: the old water culture in the region, the system of prices and tariffs of the resource, the institutional system of concessions of water use and other aspects that frame the management system. It is impossible to analyze the impacts of all of them in a single paper. However, each component is important in building a complete picture of the role of water and water policy in the future growth and development of the Iranian economy.

The first studies about water as an economic factor took part in 1950s, but operational difficulties limited the scope of their analyses. Lofting and McCaughey (1968).Became able to fix the problems by regarding water as a production factor in a traditional input-output model; then to evaluate the water needs of the Californian economy. Later on we can find many works which analyze the relationship between water needs and the different productive sectors using input-output models (Sánchez-Chóliz, Bielsa and Arrojo, 1992; Bielsa 1998; Duarte, 1999; Duarte, Sánchez-Chóliz and Bielsa, 2002; Velázquez, 2006; Dietzenbacher and Velázquez, 2006).

Several different methodologies have been explored in the analysis of water pricing (see, for example, the excellent reviews of Johansson *et al*., 2002, and Dinar and Subramanian, 1998). Many analysts have employed variants on linear programming approaches, such as those developed by Berbel and Gómez-Limón (2000) and Doppler *et al*. (2002) as well as input-output model applications such as the work of Sáenz de Miera (1998).

There is an extensive literature which has employed computable general equilibrium models, and many studies with a similar objective to the one that is the focus of the present paper. One of the pioneers was an analysis by Dixon (1990), in which he offered indications to the public authorities of Melbourne, Sydney and Perth on appropriate water prices. Horridge *et al*. (1993), and Thabet *et al*. (1999) to analyze the impact and efficiency of water prices. Nevertheless, the use of CGE to analyze the reallocation of water rights between users is less common. Seung *et al*. (1998) studied the welfare gains of transferring water from agricultural to recreational uses in the Walker River Basin (located in northwestern Nevada and in California). Diao and Roe (2000) provide a CGE model to analyze the consequences of a protectionist agricultural policy in Morocco and show how the liberalization of agricultural markets creates the necessary conditions for the implementation of efficient water pricing (particularly through the possibility of a market for water in the rural sector). By using an applied CGE, Goodman (2000) shows how temporary water exchanges provide a lower cost option than the building up of new dams or the enlargement of the existing water storage facilities. To sum up, the analysis of water allocation then requires a comprehensive view of the economy, and applied CGE methodology gives a potential framework to assess and compare policy options. For this purpose we use a CGE to analyze the implementation of a water market in the Balearic Islands. This CGE will also allow us to quantitatively and qualitatively compare the advantages of markets over other alternatives such as desalinization plants. Kumar and Young (1996) explained how a Social Accounting Matrix (SAM) can be extended to incorporate water resources and analyze the implications of water pricing policies. In a similar way, Susangkarn and Kumar (1997) used a general equilibrium model to incorporate water as a separate productive sector. Decaluwé *et al*. (1999) developed a general equilibrium model to compare different water price policies as well as to analyze water production according to the use of different technologies. Seung *et al*. (2000a) used a CGE model to evaluate the impacts of water reallocation; in a other study, Seung *et al*. (2000b) they used a dynamic model to analyze the temporal effects of water reallocation from the agriculture sector to recreational uses in rural areas of Nevada. In a similar fashion, Briand (2004) developed a static CGE model to estimate the effects of a water price policy on production and employment in Senegal. Using a slightly different CGE formulation, Hewings *et al*. (2005) evaluated the impact of water reallocation from agriculture to other productive sectors in a recursive fashion that fully captured the feedback effects. The major impact here was on agricultural employment; the reallocation of water to more productive sectors (in terms of value added) could not compensate for the enormous net loss in employment. Qin *et al.* (2012) evaluated the economic impact of water tax changes in china. The main conclusion drawn indicates the main conclusion drawn indicates that water price rise led to a reduction in total production, total exports, GDP and household welfare. Another important finding is that the tax imposed on the water has the greatest impact on the agricultural sector. Cardenete *et al.* (2011) analyzed the effects that an increase in the price of the water delivered to the agriculture sector to promote the conservation of this resource would have on the efficiency of the consumption of water and the possible reallocation of water to the remaining productive sectors. The main conclusion drawn indicates that, although the tax policy applied does not correspond to a significant water saving in the above-mentioned sector, a reallocation of this resource is achieved which seems to generate a more efficient and more rational behavior from a production point of view.

The paper has two objectives. First, we analyze the possible effects that a reducing in the various economic sectors water subsidy would have on the Iranian economy and on water conservation and Secondly, we evaluate the water reallocation to sectors of the economy generated by water price increases in various economic sectors.

General equilibrium models and water policy analysis

General equilibrium models, models that are based on a comprehensive macroeconomic structure optimized micro-economic principles to provide a review of economic policy (Kehoe *et al.*, 1983).

Walras general equilibrium models are based on general equilibrium theory by Arrow -is expanded. Walras general equilibrium model of the design so that the overall macroeconomic issues in the field of production and consumption are in balance. The model assumes that the rational behavior of individuals in the quantities supplied and demanded will apply. In fact, Walras general equilibrium system is based on the mathematical characteristics of interdependencies between production and consumption sectors of the economy can be expressed in the form of equations. How can we change the system so that each of the independent variables, the impact of different economic sectors. Walras above problem using a system of trial and error to be solved. This method of removing excess demand due to price changes and the practice continues to this surplus to zero.

Comprehensive social accounting matrixes, given the wider economic context, represent a nation or an economy is the interactions between the various inputs. SAM's total physical and financial flows in the economy at a particular point in time shows. (Lofgren *et al.*, 2002).

SAM structure and design methods are not standardized. A SAM requires only two conditions:

1- The matrix must be square.

2- All rows (total revenue) and column (total costs) for each account should be equal.

Although we can obtain some important insights from partial equilibrium analysis, this framework, when put into practice, is of a limited use for the analysis of the efficiency of water rights allocation. The main criticism comes from the fact that water is used in almost all production activities, being an essential input in many of them, and also from the fact that water value is highly dependent on time and location. Any change in the distribution of property rights over water will probably have consequences on the sectoral composition of the economic product, on employment, on costs and prices, and on the income distribution between the rural and urban sectors. A market of property rights will undoubtedly increase efficiency but, as partial analysis also leads to partial answers, in the case of water policy, when many effects are a matter of political concern, it is also necessary to provide a framework able to capture all the relevant economic effects of a changed structure of water property rights.

Basic model structure

The social accounting marix consists of activities (agriculture, industry and mining, water supply and services), commodities (agriculture, industry and mining, water supply and services), the factors of production (labor, capital, and water), inputs (households, enterprises, government and external world) are. Separate accounts, products and activities because it is a commodity may be produced by one or several activities and an activity can produce multiple products.

In order to analyze the effects of economic policies, fit the model considered in policy design and fit of the specified model can be used to reduce the effects of different scenarios of the water subsidy on macroeconomic variables in general equilibrium of the economic. The production technology uses a nested multilevel CES, as shown in Figure 1.CES (constant elasticity of substitution) functions are widely used in CGE modeling to represent both production and utility. They have the advantages of being well behaved, with a decent degree of flexibility and consistent with assumptions used in CGE models (linear homogeneity/homothecity). The standard two-variable CES production function may be written as:

$$Y = A[\beta K^{\rho} + (1-\beta)L^{\beta}]^{\frac{1}{\rho}}$$

where Y is the output, K and L the two production factors, A is a scale parameter, β and (1-β), respectively, represent the share of factor K and factor L in total factor payments and r is related to the elasticity of substitution

$$\sigma = \frac{1}{1-\rho}$$

One drawback of the CES function is that the elasticity of substitution between any pair of goods or factors is constant. To specify that this elasticity between members of one subset of goods or factors is different from the one between members of one subset and members of another, it is necessary to combine the CES with another kind of functions.

The bottom right side of Figure 1 shows the Leontief water extraction technology (RW) meaning that producing water for crops requires underground water and energy. The Leontief (fixed coefficients) function is a special case of the CES function when $\sigma \rightarrow 0$. This function is commonly used to model the use of intermediate (manufactured) inputs which are combined with the other factors of production to produce the final good. The CGE models available in the literature do not explicitly consider that water for agriculture is a produced input. Following Boyd and Newman (1991) and Decaluwe´ *et al.* [1999] we assume that capital and land are also CES aggregates (KT). First level aggregate inputs, raw water and the composite capital land are specific production factors of the agricultural sector. Similar to that of Goodman (2000), our model is more flexible than the alternatives

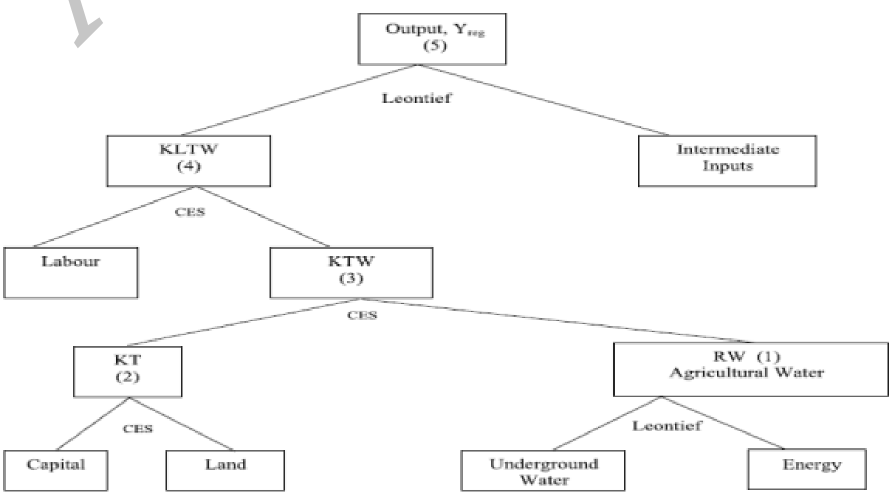

Figure 1: Nested production technology (Go´mez et al., 2004).

provided by, i.e., Seung *et al*. (1998), where land and water enter in the production function with fixed Leontief coefficients.

In a second level the composite land-capital and water are combined in the CES composite KTW, which in a third aggregation level is combined with labor (L) to obtain a CES composite (KLTW) of all capital, labor and nature production factors. Finally, the combination of all these factors with an aggregate of intermediate inputs is combined with a Leontief technology to obtain the final output (Go´mez *et al.,* 2004).

Nested production function equations

$$RW = \min\left[\frac{AS}{aa}, \frac{A_{en}}{ee}\right]$$

Where RW is the composite input water for crops, AS is the volume of underground water used, A_{en} are these of the Armington aggregate of the energy sector, and aa and ee are Leontief coefficients.

$$KT = A^{kt}\left[\beta^{kt}K^{\rho^{kt}} + (1-\beta^{kt})T^{\rho^{kt}}\right]^{\frac{1}{\rho^{kt}}}$$

Where KT is composite land and capital, K is capital; T is land, A^{kt} is the efficiency parameter, β^{kt} is the capital share parameter, r^{kt} is the substitution parameter and s^{kt} is the substitution elasticity.

$$KTW = A^{ka}\left[\beta^{ka}K^{\rho^{ka}} + (1-\beta^{ka})T^{\rho^{ka}}\right]^{\frac{1}{\rho^{ka}}}$$

Where KTW is composite KT and RW, A^{ka} is the efficiency parameter, β^{ka} is the share parameter, r^{ka} is the substitution parameter and is substitution elasticity.

$$KLTW = A^{la}\left[\beta^{la}K^{\rho^{la}} + (1-\beta^{la})T^{\rho^{la}}\right]^{\frac{1}{\rho^{la}}}$$

Where KLTW is composite KTW and labor, L A^{1a} is labor, β^{1a} is the efficiency parameter, is the share parameter, and r^{1a} is the substitution parameter, and s^{1a} is substitution elasticity.

$$Y = MIN\left\{\frac{KLTW}{vaa}, \frac{A_1}{iia_1}, \frac{A_2}{iia_2}, \dots, \frac{A_g}{iia_g}, \frac{II_1}{iia_1}, \frac{II_2}{iia_2}, \dots, \frac{II_i}{iia_i}\right\}$$

where g ϵBM is a set of traded production sectors, $i \epsilon BNM$ is a set of nontrade production sectors, Y is output of irrigated agriculture, II_i is use of the intermediate input of the sector i, A_g is use of the Armington(1969) aggregate of the sector g, and vaa, iia_g iiag, and iia_i, are technical fixed coefficients (Go´mez, 2004).

RESULTS

The goal of this research is analyzed the effects of reducing water subsidies on GDP. Reduce the impact of subsidies on the part of Water on GDP in each of the sectors were calculated and in table (1) is shown.

We have simulated changes in the reducing water subsidies on various economic sectors, with six different scenarios. As it can be observed, these simulations assume that the water price is increased significantly, with a consequent potentially heavy sacrifice on the side of the farmers. The reason for high impact in agricultural sector is that about 90 percent of water resource is used in this sector due to low water price. Thus, increasing water price led to increase in production price. This, in turn, causes the decrease in agricultural production. This is the point that government should support and help farmers in order to prevent production decrease.

According to table (1) the results of the impact of reducing water subsidies in the form of scenarios are given on GDP. Every six scenarios, reducing water subsidies (50, 100, 200, 300, 400 and 500), highest and lowest impact are related to agricultural and water supply sector, respectively. However, the impact of decreasing production in the industry and mining as well as services is negligible. And also the results show that economic growth in various scenarios to reduce water subsidies in agriculture, water supply, mining industry and services, respectively; from 0.57, 0.06, 0.16 and 0.35 percent in the first scenario to the 4.51, 0.66, 1.53 and 3.30 percent in scenario six is decrease.

It is very important to show that the presence or absence of a water market plays a crucial role in the assessment of the convenience of maintaining the existing facilities to increase the supply of raw water (or of building new facilities for the same purpose). In the case of our model, the existing water desalinization plant represents this kind of facilities. As water markets will result in a better allocation of water among various economic sectors

Table 1: effects on domestic production to reduce water subsidies in various economic sectors in 2001 (billion rials)

	Current Status	50% reduction in water subsidies	100% reduction in water subsidies	200% reduction in water subsidies	300% reduction in water subsidies	400% reduction in water subsidies	500% reduction in water subsidies
Agricultural sector	112630	112050	111443	110330	109331	108429	107612
Changes to the current situation (percent)		-.57	-1.11	-2.1	-2.98	-3.78	-4.51
Department of Water	3041.7	3039.7	3037.6	3033.6	3029.6	3025.6	3021.6
Changes to the current situation (percent)		-0.06	-0.13	-0.27	-0.4	-0.53	-0.66
Department of Mining and industry	426907	426207	425519	424174	422870	421606	420379
Changes to the current situation (percent)		-0.16	-0.32	-0.64	-0.94	-1.24	-1.53
Services	401349	399934	398539	395804	393141	390547	388019
Changes to the current situation (percent)		-0.35	-0.7	-1.38	-2.04	-2.69	-3.32

Source: Research findings

water production.

CONCLUSION

A complete model was determined in order to investigate water resources and then six scenarios for reducing water subsidies (50, 100, 200, 300, 400, and 500%) were applied. Finally, by comparing the findings achieved by simulated computable general equilibrium, the impact of price shock on GDP was analyzed.

The results show that in all six scenarios about reducing water subsidies (50, 100, 200, 300, 400 and 500%), highest and lowest impact are related to agricultural and water supply sector, respectively. However, the impact of decreasing production in the industry and mining as well as services is negligible. The reason for high impact in agricultural sector is that about 90 percent of water resource is used in this sector due to low water price. Thus, increasing water price led to increase in production price. This, in turn, causes the decrease in agricultural production. This is the point that government should support and help farmers in order to prevent production decrease.

SUGGESTIONS

1 – Government can prevent the decrease in production by redistributing incomes.

2- Low-interest loans and tax breaks for entrepreneurs is to motivate the implementation of water saving, water saving will result.

3 - The computable general equilibrium models, the parameters of the model and the stretch can be exogenous. And the results of the sensitivity analysis can be carried out, and compared the results with different scenarios for traction.

4 - Standards for Imports efficient technology in order to make optimum use of water resources.

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