

Analysis of the Response of Small and Medium Farmers Incentives for Investment in Water Saving

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Abstract The review of current water balance of Tunisia as a result of increasing demand and a stagnant supply reveals a situation of water stress, an endowment of nearly 450m³/an/habitant. The irrigated sector, the largest consumer of this resource (80%) would be the first affected by this situation. To reduce the effects of water scarcity on irrigated agriculture, the government has designed and implemented since 1995 a national program of water conservation. Significant positive incentives have been decided to encourage farmers to adopt new irrigation techniques offered by this program. It is clear that despite the importance of subsidies for investment in water-saving equipment (60% of the amount invested), the equipment rate remained below the expected objectives. The present work aims to define a methodological approach and test to explain the slow growth of water-saving program and analyzing adoption decisions of the proposed techniques by small and medium farmers. The data used to estimate the model specified is collected by survey of 40 small and medium farmers belonging to a private irrigated area Abida Kairouan Governorate. The results show that the effects of eliminating the interest subsidy is higher than the subsidy rate of capital. So the reaction of small and medium farmers is slow vis-à-vis technological change, and must be supplemented by other types of interventions. Thus, the instrument implemented is not effective. The remainder of paper is organized as follows: In the first section, we will present the general framework and then the specific context and the background information in order to introduce the problem and the research methodology. The second section will develop the background literature of our work. In the third section, we will discuss the various results of the work. Finally, the last section talks about the findings and to remember the different political implications of this research.

Keywords: irrigated agriculture, water saving, private investment, agricultural policies, investment incentives

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1. Introduction

The irrigated area is characterized by the variety of water resources exploited (dams, hill dams, boreholes, shallow wells, treated wastewater). This imposes differences in size, configuration, and equipment type management of these areas. Similarly, operating modes and levels of agricultural intensification are unequal and depend on regional climatic conditions and socio-economic.

The agricultural water demand continues to increase due to changes in the rate of intensification in existing schemes, and the concomitant expansion of the newly appointed area. This is currently estimated at 1,575 Mm³ request evolve at 2540 million m³ by 2015 and will constitute 80% of the overall water demand of different socio-economic sectors in the next decade.

To meet this demand, the irrigation sector in the future will face a tougher competitive situation because of limited water resources and increasing demand from

sectors of drinking water, tourism and industry considered more competitive.

To overcome this fierce competition from other sectors, taking into account the scarcity of water resources, we must create a favorable environment for raising hope such challenges in the very near future, and raise the economic performance of the irrigation sector suffers from several weaknesses including:

- The low-tech irrigators in new areas, which results in a lack of awareness of actual crop needs at different stages of growth and behavior of crops to changes in inputs, and poor consideration of cultural techniques as tools of water saving (leveling, soil preparation, windbreaks, etc.).
- The level of pricing as an incentive to rationalize the use of water remained long enough, despite the progress made in recent years.
- The degradation and obsolescence of structures and equipment in some old schemes, greatly reducing the efficiency of collective irrigation systems, and do not allow users to provide security in the water supply and quality desired service.

This is why long-term goals were set at the irrigated sector and can be summarized as follows:

- The development of intensive agriculture of high economic value to meet the needs in fruits, vegetables, dairy products, industrial crops. .. and make exportable surpluses (citrus, dates, greengrocers. ..). Irrigated sector participation would be estimated long-term to a level of 50% of total agricultural production.
- Complementarity with rainfed agriculture, fragile nature, and of limiting the negative effects of drought, particularly for the production of certain commodities (cereals, meat. ..).

We consider that much of the waste of irrigation water is due, in addition to the weakness of institutional mechanisms to a pricing policy (which is based on non-economic measures), lack of sophistication of irrigators and an inadequate irrigation system.

To reduce the weaknesses of the current operation, it is necessary to improve irrigation systems. Hence, the rational exploitation of resources is governed by modern techniques for increasing efficiency of water use, maximizing the value of m^3 of water. However, any technological change requires not only technology but also requires financial capital. This will involve the creation of an investment relative to the installation of new water-saving equipment. The adoption of such technology reduces costs related to this factor of production irrigated (water) and consequently lead to improved income of the producer. However we can expect a reluctance of farmers about the acquisition of new irrigation techniques. Indeed, the persistence of some constraints can justify this reluctance:

- The agricultural environment is characterized by uncertainty more pronounced as the rest of the economy. This uncertainty is linked to climatic events that may affect the results of the sector.
- To invest, some farmers (particularly small) have an activity whose economic viability does not always obey the standards and criteria of the banking system, limiting their access advantage to bank credit. Therefore the cost of investment in water saving equipment is considered high for this category of farmers.

These constraints, it adds the new changes in the international economy; liberalization of trade (GATT), liberalization of economies of Eastern Europe and the creation of a united Europe etc, which impose new priorities to ensure a competitive national economy towards a global free market. These objectives can be summarized in a rapid and sustained growth of exports and investments that meet the additional demands of jobs and contribute in reducing the deficit of the trade balance. Therefore, a reconsideration of the system of incentives for investments is raised to correct the shortcomings of the old policy and create a more open on the external economic environment. The enactment of Law No. 93-120 of 27 December 1993 is included in this framework.

This new investment incentive code or "unique code" is justified by the pursuit of structural adjustment programs and economic reintegration of all sectors to achieve national objectives. In fact, it provides for the harmonization of the provisions relating to old policies and the granting of new tax and financial benefits. In this

context, the development of agriculture, including irrigated agriculture, is retained as a priority macroeconomic goal. Therefore, in addition to the common benefits, irrigated agriculture should benefit other specific incentives such as raising the subsidy rate on capital and tax exemption of taxable income in case of reinvestment.

To overcome these constraints, the State has developed instruments of investment incentives as a means of very powerful intervention at the direction of private investment. As a result, incentives for investment are a factor among many that influence the behavior of the farmer in this area. The most important first step in the process of reforming the system of incentives is **the substitution of the bonus interest rates by investing premiums.**

Indeed, the new system provides investment incentives for the capital invested in agriculture, increasing the subsidy rate on investment, the eliminating of the interest subsidy on credits allocated. The components of policies to encourage investment result in the modification of the user cost of capital. This cost reflects the impact of policy variables for private investments in hardware saving irrigation water.

It should be remembered that the cost of capital is explained by several factors including:

- The rate of interest subsidy funds allocated to investors. This rate represents the share of the cost of debt incurred by the State. The eliminating of the interest subsidy will cause a rise in the cost of capital. Therefore, this instrument has a negative impact on investment decisions.
- The subsidy rate on capital represents the share capital of the financial costs supported by the State. (Malinvaud, 1970).

The increase in this rate will decrease the cost supported by the investor. This instrument will have a positive effect on investment decisions as a result. Thus, through such instruments of investment incentives, the state seeks to guide the behavior of farmers and stimulate private investment in agricultural water-saving equipment.

Our article is part of this research framework integrating taxation in business decisions. Our goal is to try to bring elements of answers explaining the relationship between taxation and investment decisions.

In view of what has been presented, one is tempted to ask the following question: What is the impact of the current policy incentives on private investment in water saving?

To assess the impact of each of the above-mentioned instruments on private investment, we define three scenarios incentive policy.

2 Theoretical and Methodological Framework for Analysis

Scholes and Wolfson (1996) have developed a conceptual framework for integrating the taxation in investment decisions and financing of the company. The framework conceptual did not bring new theories or methodologies, but the authors adopt a positive approach in trying to explain the role of taxation in the organization.

This conceptual framework is fundamental to tax research, accounting and finance.

Shackelford and Shevlin (2001) point out that taxes research raise some methodological problems concerning particular rate estimation of marginal taxation, model specification, the specification of variables level or variation and availability of data.

Researches in this area are mainly Anglo-Saxon origin. By Referring to Modigliani and Miller (1963), the income tax in their study on the existence of an optimal capital structure while nuancing their position in 1958, many Anglo-Saxon authors monitoring different topics related to taxation and investment decision, taxation and financing decisions, taxation and capital structure, dividend taxation, and others.

Douglas (2001) and Plesko (2000) state that the measure of the tax rate is an important step in tax research and may impact on the results. Different approaches are taken in estimating the rate taxation. In their studies, Zimmerman (1983), Porcano (1986), Terando and Omer (1999) retained the measure of the average effective tax rate. However, Shevlin (1990) and Graham (1996a) adopted a simulation technique to determine the marginal tax rate that has been widely adopted by Subsequent studies (Graham et al. 1998; Graham, 1999; Mackie III, 2002 and Feenberg and Poterba, 2004).

Some studies have investigated the effect of tax incentives on investment, such as investment tax credits (Hassett and Hubbard, 1998; Chirinko, 2000 and Thomas et al.1996) and the alternative minimum tax (Lyon, 1990), while Hassett and Cummins (1992); Borrego and Bentolila (1994); Cummins et al. (1995) studied the impact of tax adjustments on the ratio of Tobin's q. In the same context, Arcelus et al. (2005) examined the effect of delay tax on the ratio of Tobin's q.

Other studies have highlighted the effect of tax on the corporate income and personal tax on cost of capital (Auerbach, 1983; Stiglitz, 1983; Mayer, 1986; Taggart, 1991; McKenzie and Thompson,1997 and Crepon and Gianella, 2001). Similarly, Gale and Orszag (2005) studied the interaction between the deficit situation, the interest and cost of use and their impact on investment decision.

To sum up several models to explain the investment function have been developed. Among them, we selected in our case the work of Blejer and Khan (1984).

2.1. Basic Model (Table 1 in Annex)

Recall that the shape of the estimated model is:

$$I_t = -614 + 0,54\Delta VA_{t/m}^3 - 0,06DI_{t-1} - 1,68UCC_t + 3,96BC_t + 0,08PW_t \quad (1)$$

Table 1. Définition of variables

Variables	Definitions
I_t	Includes expenses related to distribution and irrigation, such as the creation of shallow wells, installation of mobile pipes, basins, emitters, sprinklers etc. ..
VA_t	Value added is equal to the output sold minus inputs except water.
DI_{t-1}	Delayed investment that includes the basic infrastructure of the old equipment.
UCC_t	The user cost of capital depends on the purchase price of equipment (q) the interest rate of tax rates.
BC_t	The amount of bank credit.
PW_t	The price of water, which is approximated by the costs incurred such as water (fuel, electricity, Mo., maintenance. ..).
α	Accelerator long term (LT) measuring the increase in production capacity at LT.
α_{a0}	Short term effect of a change in demand, equated with the production on private investment. It is the effect of acceleration corrected by the coefficient (a_0), which reflects the rigidity of economic structures. This parameter is theoretically positive.
$(1 - a_0)$	The effect of the investment lagged one period. This is a part of the investment will be used to preset with new acquisitions constitute the new irrigation system. What makes the investments made during the previous period do lighten the new achievements. Therefore, the negative sign that may make the setting for this regressor.
α_1	Effect of instantaneous user cost of capital on private investment. The introduction of user cost of capital in the model based on the assumption of cost minimization at the time of initial implementation of the project characterizing the behavior of the investor. Any increase in the user cost of capital reduced reproductive capacity of enterprises. This parameter is nominally negative but it should be noted that the grant (part of the user cost of capital) can act positively on investment by reducing the cost of capital at acceptable levels, making the sign of the positive parameter.
α_2	Instant effect of bank credit on private investment. Bank loans are a source of investment financing, their availability to an effect of lightening the financial constraint imposed on private entrepreneurs in the financial market. This parameter is normally positive.
α_3	Instant effect the price of water on private investment. Since any increase in water prices caused an increase in private investment for the adoption of water saving techniques, this parameter is normally positive.

• Student's t:

(1.98) (-0.28) (-2.27) (5.2) (0.51)

• **Durbin H:** The comparison of the calculated Durbin h with the h theory showed that the regression coefficients of residues, a process autoregressive first order, are not significantly different from zero (Table 2).

• **$R^2 = 0.78$**

• **F = 55.24**

• **Signs of the coefficients:** (Complies with theoretical expectations)

Table 2. Results from estimating the model using the Cochrane-Orcutt

Variables	Coefficient	Student T	Elasticity*
Short term Acc	0.54	1.98	-
Long term Acc	0.50	-	-
DI_{t-1}	-0.06	-0.28	-2.75
UCC_t	-1.68	-2.27	-52.9
BC_t	3.96	5.2	87.16
PW_t	0.08	0.51	0.06
$R^2 = 0.782$. Adjusted $R^2 = 0.734$. F-statistic = 55.242. Dh = 1.926			

* Elasticity in an average point. Source: Our calculations

2.2. Theoretical Model

The review of the formula for the cost of capital shows that this cost is based on the subsidy rate, the interest subsidy and depreciation of equipment (Malinvaud, 1970).

The shape of the estimated model is:

$$I_t = \alpha a_0 \Delta VA_{t/m}^3 + (1 - a_0) DI_{t-1} + \alpha_1 UCC_t + \alpha_2 BC_t + \alpha_3 PW_t + e_t \quad (2)$$

The new specification of the model can be written as:

$$I_t = \alpha a_0 \Delta VA_t + (1 - a_0) DI_{t-1} + \alpha_{11} DE_t + \alpha_{12} FC_t + \alpha_{13} G_t + \alpha_2 BC_t + \alpha_3 PW_t + e_t \quad (3)$$

$$= \alpha_{11} DE_t + \alpha_{12} FC_t + \alpha_{13} G_t + \Phi(x)_t + e_t$$

Where,

$$\Phi(x)_t = \alpha a_0 \Delta A_t + (1 - a_0) DI_{t-1} + \alpha_2 BC_t + \alpha_3 PW_t,$$

DE: Depreciation of equipment

FC: The financial costs supported by the investor,

G: The grant obtained.

2.3. Content of the Scenarios

To evaluate the impact of each of the instruments of investment incentives, we will define three scenarios incentive policy. The definition of these scenarios reflects the elimination of the interest subsidy and the elevation of the grant.

Scenario 1: Base case

The instruments defined by the policy of investment incentives are consistent with the new incentive plan (Established in 2004).

Scenario 2:

The instruments defined by the policy of investment incentives match those of the former regime of incentives (Established in 1994).

Scenario 3:

This scenario only takes a change in the rate of interest subsidy.

2.4 Specification of the Model to Estimate

The absence of a time series of data used has led us to assume that the regression coefficients and the explanatory variables, except the cost of capital, retain the same values as the old and the new incentive plan. For the purpose of refining the analysis, we took into account disparities in types of investments. To distinguish the different investment categories (A and B), we used two variables (D_i , cat_i).

The model then becomes:

$$IB_{t,s} = \psi_0 + \psi_1 D_1 + \psi_2 D_2 + \alpha_1 DE_{t,s} cat_1 + \alpha_2 DE_{t,s} cat_2 + \alpha_3 DE_{t,s} + \beta_1 FC_{t,s} cat_1 + \beta_2 FC_{t,s} cat_2 + \beta_3 FC_{t,s} + \lambda_1 G_{t,s} cat_1 + \lambda_2 G_{t,s} cat_2 + \lambda_3 G_{t,s} + \Phi(x)_{t,s} + e_t \quad (4)$$

Where,

s: Scenario 1, 2 or 3, cat_i and D_i are variables that take the following values

Table 3. Values of dummy variables

	Cat1	Cat2	D1	D2
Cat1	1	0	1	0
Cat2	0	1	0	1

Finally, the gap categories, the effects of policy scenarios to compare incentive are calculated as follows:

$$\Delta I_j = I_{j,s2} - I_{j,s1} \text{ (Impact of scenario 2)}$$

$$\Delta I_j = I_{j,s3} - I_{j,s1} \text{ (Impact of scenario 3)}$$

2.5. The Hypotheses of the Work

The main hypotheses for the specification of the function chosen are:

- The control policy, based on the criterion of water efficiency can be an effective way on a large scale but not on the extent of a zone. Indeed, the cropping system can not be so diverse to better allocate the m^3 of water.
- Water consumption is largely dependent on the irrigation system installed; any time such technology requires the commitment of capital that is not always accessible to the small farmers. Hence, the intervention of the State seems to be an important way for the establishment of the irrigation system.
- The credit remains the main recourse for small and medium farmers, when the only self financing alters the investment policy; however the conditions for obtaining a credit are difficult.

2.6. Data Used

According to the research project MERGUSIE¹, it has been obtained information relating to irrigation techniques by farmers, irrigated and irrigable crops grown by farmers and the list of farmers in the study area. However, useful information is unknown for some farmers, the rate of actual land under irrigation which allows us to infer the realized returns.

To quantify the other exogenous variables, the methodology adopted in this research is based on the use of survey data (83 farmers) for one year; we carried out in the delegation of CHEBIKA. The information collected concern a sample of farmers in the area and are arranged in cross section. The list of farmers available to the Agency for the Promotion of Investment in Agriculture (APIA) was tested according to data from the research project and those of the Regional Commissioner of Agricultural Development (RCAD) to set a final list which is our population to investigate. Thus, to explain the behavior of investors in the field of water conservation, the database used in this work is made from the data of the APIA.

It should be noted that the sample includes 83 farmers, who have made investments and get bank loans or special fund for agricultural development (SFAD). Thus, this large number of observations may favorably affect the

¹MERGUSIE: mobilizing national project on the river Merguellil located at Al Qayrawan (center of Tunisia) created in 1997. The project includes a set of institutions of research and development.

reliability of the result. This choice is based on the acceptance of the farmer of any technological innovation.

To respect the proportionality of the sample relative to the parent population, we worked on a sample of 40 farmers in the Class A (small size) and B (medium size). The objective of the questionnaire is to collect additional data, and verify certain information available to the RCAD and APIA (Table 4).

Table 4. Sample allocation by investment category

Category	Category A	Category B	Total
Size			
Size of the parent population	200	320	600
Sample size	15	25	46
Percentage	0,075	0.09	7,6

Source: Our calculations

2.7. Estimation Procedure

Since all observations have different weights in the estimation of private investment, a problem of heteroscedasticity may appear. To correct the data, we will apply a weighted regression.

Consider the model to estimate the following:

$$I_t = \alpha_0 + \alpha_{11}DE_t + \alpha_{12}FC_t + \alpha_{13}G_t + \Phi(x)_t + e_t \quad (5)$$

Where, $E(\varepsilon_t^2) = \sigma^2 \cdot \frac{1}{w}$ and $t = 1, \dots, 46$.

$$w = \frac{1}{N} \sum_{t=1}^N w_t$$

I_t , DE_t , FC_t , G_t and W_t are observable variables and α_i and σ^2 are unknown parameters.

The weighted least squares estimator $\hat{\alpha}_w$ is obtained by applying OLS (The method of least squares) to the transformed model:

$$\sqrt{w_t}IB_t = \alpha_i \sqrt{w_t} (DE_t + FC_t + G_t + \Phi(x)_t) + u_t \quad (6)$$

3. Results and Discussion

The results of the effects of policy instruments of investment incentives by investment category are shown in Table 5.

Table 5. Effect of new incentive instruments by investment category (MD)

Category	Impact	Overall impact		Impact by investment category				Total/category	
		Value	%	Category A		Category B		Value	%
				Value	%	Value	%		
I ₁	Scenario2	(125159)	(0.5)	(203)	(0.03)	(1563)	(0.27)	(2230)	(0.38)
	Scenario3	(125154)	(0.4)	113.9	0.017	760	0.13	1100.87	0.19
I ₂	Scenario2	7904	0.75	(37.5)	(0.008)	(185.21)	(0.04)	(539.13)	(0.14)
	Scenario3	7886	0.78	181.73	0.047	723.48	0.18	2271.3	0.592

According to this table, we note that the behavior of the farmer, regardless of its size, is positively influenced by an increase in the investment premium. Indeed, there is an increase for investment following an increase in the grant which is about 203MD and 1563MD respectively at the Class A and B. This increase is about 0.5% for the entire population during the same period. So, the new incentive system encourages all types of investments (small and medium farmers).

Besides, we find that the effects of eliminating the interest subsidy are higher than the subsidy rate on capital for all investment categories. Indeed, the investment volume has increased due to a change in the rate of interest subsidy, it is about 114MD and MD 760 respectively at the Class A and B. Completely there was a decrease in investment volume of 0.3%. So the increase in the investment premium, by category of investment, did not offset the effect of the eliminating of the interest subsidy.

It should be noted that the same effects are observed during the following period. Indeed, by category of investment, the effect of increasing the grant and the elimination of the interest subsidy keep the same signs as compared to the previous year, whereas overall the signs are reversed. So the effect of new incentive instruments is not the same at the global level and category of investment. This is explained by differences by category of investment. This may mean that the new incentives, by category of investment, are quantitatively insufficient.

Hence, the effects of eliminating the interest subsidy are higher than the subsidy rate of capital. So, the small and medium farmers' response is slow vis-à-vis

technological change, and must be complemented by other interventions. Thus, the instrument is not implemented effectively.

4. Conclusions and policy implications

The objective of this study was to clarify the determination of changes in demand for private investment in hydro-agricultural and analyze qualitatively and quantitatively the main factors that influence investment decisions in private materials for water conservation. Thus, the methodology was an econometric approach to measuring the effect of potentially explanatory variables exogenous of private investment in water saving devices.

The empirical study focused on the econometric estimation of the demand function for private investment in water saving devices. It is based on data, arranged in cross section, of a sample of 83 farmers conducted in the region of CHEBIKA. It is a choice that is integrated in the project MERGUISIE.

The simulation work showed that new incentives for investments made by the State in order to compress the cost of capital and keep it within tolerable limits, encourage the small and medium farmers to invest, but their impact is low. This means that raising of the subsidy rate of capital, as defined by the new code of investment incentives (2004), can not offset the effect of eliminating the interest subsidy. Hence, the need to supplement the incentives, or by increasing the subsidy rate beyond its current level, to offset the effects of eliminating the

interest subsidy, or to simplify the conditions relating to access for agricultural credit. This promotes all kinds of substitution between the cost of capital (through the grant) and the price of water.

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