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The determinants of the demand for water for agriculture: an econometric study applied to the case of the regional Office of Agricultural Development El Haouz

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Introduction

In this econometric study, we are interested in water demand for the use of irrigation in Morocco trying to determine the most important parameters that influence the demand for agricultural water consumption of water irrigation is measured through the supply dams. Each Regional Office for Agricultural Development (ORMVA) is fed by one or more dams.

To ensure the protection of cities against floods, the volume of water retained should ensure artificial groundwater recharge on which the deductions are made without exceeding the capacity and at the same time does not meet the demands. To study the effectiveness of charging and its impact on the water table, including a coupled surface and subsurface runoff is developed by Y. Nazoumou and Mr. Besbes. This model allows for the water balance in order to quantify the effective infiltration flow. But, in this analysis we follow the approach applied by the ORMVA to equip farmers with irrigation allocations.

The study will focus on ORMVA of HAOUZ

The endogenous variable: consumption of irrigation water

The approach used to determine the amount consumed (releases) is as follows:

- Collect data on the supply of irrigation water from the dams;
- Search for correspondences between / play (s) and ORMVA, ie what is the / play (s) which provides (ze) water to ORMVA

This gives us the consumption values within each irrigated area, the lack of data prior to 1980 has forced us to set the analysis from this year, in addition to the variable consumption is the most important variable in the model because it is the variable that seeks to explain, therefore it must be true and accurate.

Formulation and assumption of the model

are:
Ct: the consumption of irrigation water or the application of water to irrigation use
Pt: the irrigation water tariff or price of water
Rt: The irrigated area
PRt: rainfall or precipitation
TP: temperature
t: The variable time (trend)
μ: the random term
therefore:
Ct = f (Pt, Rt, PRt, TPT)
Ct = ao + a1 + a2 Rt Pt + a3 + PRt a4TPt + μ
However, most authors have a preference for the log-linear form, as the additive form, high-mentioned, give some significant results and that is what we will validate our model.
So the log-linear form is:
LCt = ao + A1L Pt + a2 + a3 LRT LPRT + a4 + μ LTPt
L: the logarithm operator
In this model we assume that:
H0: the amount of water supplied by the dam and the exact quantity demanded by farmers.
H1: the payment of the price of water is equal and that farmers pay all the time fixed by the ORMVA
H2: precipitation is totally effective rainfall that is: the rain that falls is completely consumed by plants.
H3: all irrigated areas are well equipped for irrigation.
Our research processes data from 1980 to 1999, in fact, have the data available at the moment.

Econometric study: the case of the irrigated perimeter of El Haouz

To address issues at mentioned above, we have adopted a model-centric approach to relations in the demand for irrigation water and other variables that may explain this request. This approach appeared to us relevant to first structure the processes involved, whether technical, economic, organizational, and their interrelationships, secondly build a global representation of the problem, which is shared by all stakeholders of an organization , third power forward thinking on the solutions to be implemented. Modelling is a useful way to light the issues that are important for leaders, but it would be naive to believe that the models are able to develop solutions What could apply generally because their validity is based on assumptions starting that underlie them.
The econometric study, we will carry out, is based on annual data time series over a period ranging from 1980 to 1999.
The objective of this study is to develop an ability to estimate irrigation water demand under a time criterion. But the specific objective of this research is to develop a model for perimeter El Haouz and Souss-Massa with the ability to estimate the amount of water that will be required based on price, areas and precipitation temperature.
Therefore, this study aims to provide answers to the following questions:
To what extent the price, the irrigated area precipitation and temperature affect the demand for irrigation water?
How do the farmers in the context of this model to a change in the price of water: main factor of this model?
It should be noted that the price of water at the perimeter of El Haouz does not include the pumping fee (unlike him Sous-Massa). Indeed this scope has a natural uplift and therefore we do not need energy to bring water to the plots and from there, farmers use surface water. for example, “60% of the area of the water basin Oued Ouricka varies between a slope of 15% to 50%.”
The absence of the pumping fee is one more reason reflecting on the choice of this scope, thus calculating this tax is difficult to achieve (average of all lockers perimeter).

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For this purpose the water tariff is as follows:
P = TE + TP
Along With:
P: The water sales price
TE: the equilibrium rate
TP: pumping fee
Or in the Haouz TP = 0 which gives P = TE
Obviously this pumping fee increases with decreasing groundwater stock, indeed "groundwater is exploited because the pumping rate exceeds the rate of recharge."
We will test the model using three methods we think the most suitable:

- The ordinary least squares (OLS)
- The method of maximum likelihood (MaxL)
- The method of hilu

The additive model:: $C_t = a_o + a_1 P_t + a_2 R_t + a_3 PR_t + a_4 TP_t + \mu$

variables	OLS	MAXL	Hilu
Constant	-256.79 (-0.17)	591.77 (0.45)	1158.65 (0.75)
Price	-291.87 (-1.67)	135.54 (0.70)	169.22 (0.85)
area	0.72 (0.33)	0.45 (1.30)	0.38 (1)
precipitation	0.30 (0.57)	0.31 (0.75)	0.46 (0.99)
Temperature	19.05 (0.44)	16.004 (-0.44)	-0.29 (-0.72)
R²	0.38	0.50	0.52
B bar²	0.20	0.31	0.32
DW	1.64	2.03	2.13

Is found that the regression by OLS present unsatisfactory results, in fact, a negative constant with a small t student, a positive sign associated with the variable precipitation, which contradicts the theory with a small t and student very low R². Note that only the variable price that is consistent with that suggested by the law of demand and Student t is practically acceptable.
As for the results of the regression maximum likelihood (MAXL), we can see that all the Student t are weak and some signs are not in line with expectations (Price and precipitation) and R² is improving but weakly. The method of Hilu also highlighted poor quality results, indeed all Student t are low and, with the exception of the constant and the variable area, all other signs are non-compliant.
The logarithmic transformation, which allows, on the one hand to reduce the quantities of data differences for the variables of the model and also to provide a good approximation of the values of the elasticity of demand of water compared to other exogenous variables, can give more realistic results.
The logarithmic estimate by the three methods the following results:
The logarithmic model: LCt = ao + a1 + a2 LPt LRT + a3 + a4 LPRT LTPt + µ

variables	OLS	MAXL	Hilu
Constant	6.83 (0.63)	5.18 (0.43)	-6.87 (-0.50)
Price	-0.34 (-2.007)	0.18 (0.83)	0.36 (-2.25)
area	0.54 (1.52)	1.13 (1.72)	0.27 (0.74)
precipitation	0.47 (0.24)	0.88 (0.49)	0.21 (-0.87)
Temperature	-2.07 (-0.64)	-3.40 (-1.11)	2.98 (0.66)
R²	0.50	0.57	0.58
B bar²	0.35	0.40	0.40
DW	1.75	2.10	1.58

Even in the logarithmic model, the results are not consistent for all three methods and for most of the variables of that model.
In discussing these issues on several occasions with leaders in specialist departments and agencies (ORMVA, Administration of Rural Engineering, Hydraulic Direction ...), it turned out that farmers are based mainly on what they paid for last year, in other words you have to test a model that, in addition to existing variables, the variable must include the price of the past (delayed prices).
So farmers are trying to adapt to the previous situation according to their budget constraint. This is what has been explained by the adaptive expectations theory.
In the early 50s, formidable theoretical battles are committed on the role of expectations, especially in speculation. In the 60s, we will attend two opposite approaches in determining expectations in an uncertain universe. The first approach based on the concept of rational expectations, will take account of all efficient information, ie all the information that may influence the variable. The second approach, which interests us most consider every variable as a stochastic process and will take account of past values is what has been called adaptive expectations. The general principle of adaptive anticipation theory is Always provide the future value of a variable from its present value and the forecast error made in the past period. It is the recognition of this error (assigned a coefficient between 0 and 1), which is the origin of the term "adaptive". Thus, this rule returns to forecast from a weighted sum of past values of the variable, the weights decrease exponentially as the past recedes. Mr Friedmane which introduced the principle in the monetary field, the adaptive expectations are made on the basis of observations of the past. Rising early prices, for example, is based on the experience gained in previous years. However, these expectations may be biased, in fact, individuals are systematically wrong, especially when changing the process of rising.
Under these conditions the expectations formation process may seem irrational affirm that individuals (especially farmers who are neither omniscient nor economists and econometricians are unable to understand the mechanisms of the economy) consistently make mistakes is more restrictive than to admit they are wrong on average ever. The role and structure of the expectations have largely dominated the theoretical debates on the determination of macroeconomic variables (consumption, prices, income ...) for over forty years.
The econometric point of view, the basic idea is that the evolution of the past allows a linear representation of anticipated changes

From the econometric work on staggered delays, the literature has provided numerous examples especially on the phenomenon of hyperinflation (variable price)
So based on this theory and what actually happens in the behavior of farmers, it has integrated the variable delay prices.
The use of the only variable prices delayed in the model leads to the following results:

$C_t = a_o + a_1 P_{t-1} + a_2 R_t + a_3 PR_t + a_4 TP_t + \mu$

variables	OLS	MAXL	Hilu
Constant	1.82 (0.13)	7.06 (0.65)	15.99 (1.39)
delay prices.	-0.46 (2.81)	-0.44 (-2.78)	-0.45 (3.05)
area	0.19 (0.53)	0.33 (0.73)	0.12 (0.26)
precipitation	-0.75 (-0.35)	-0.13 (-0.92)	-0.11 (-0.82)
Temperature	0.51 (0.12)	1.28 (-0.39)	3.13 (-.95)
R²	0.63	0.78	0.80
B bar²	0.52	0.69	0.70
DW	0.74	1.81	2.37

It is noted that all signs are in accordance with what is suggested by the theory and for all three methods, but the most important point is that the student T associated with delayed price variable are highly significant (2.81; 2.78; 3.05) that confirming what was mentioned above. Moreover, this does not prevent us compare the two variables (prices and delayed prices) in the same model.
The inclusion of this variable (Pt) gave the following results:

$C_t = a_o + a_1 P_t + a_2 P_{t-1} + a_3 R_t + a_4 PR_t + a_5 TP_t + \mu$

Variables	OLS	MAXL	Hilu
Constant	1.64 (0.12)	6.11 (0.55)	16.34 (1.39)
price	-0.17 (0.88)	-0.15 (0.90)	-0.21 (1.36)
delay prices.	-0.35 (-1.65)	-0.45 (-2.85)	-0.46 (-3.23)
area	0.15 (0.42)	0.47 (0.88)	0.12 (0.22)
precipitation	-0.14 (-0.64)	-0.67 (-0.42)	-0.33 (-0.23)
Temperature	0.78 (0.18)	1.52 (-0.47)	3.28 (-1.06)
R²	0.70	0.80	0.82
B bar²	0.61	0.70	0.71
DW	1.03	1.83	2.43

A first reading of the table we see that, for all three methods, the results are good quality indeed important R², all the signs are consistent with what the theory suggests.
There is no denying that there are tons of insignificant student, however, it should be noted that the Student t attached to the prices and lagged price variable are significant.
The estimated values in this model represents elasticities of demand with respect to these variables, these values are as follows:

Elasticities of demand for irrigation water compared to prices; delayed price; area; precipitation and temperature

Les élasticités	OLS	MAXL	Hillu
price	-0.17	-0.15	-0.21
delay prices.	-0.35	-0.45	-0.46
area	0.15	0.47	0.12
precipitation	-0.14	-0.67	-0.33
Temperature	0.78	1.52	3.28

Conclusion

The water is therefore an exceptional and vital raw material alone whose use has an impact back on the field. The water was often used by states, firstly to define a border, the other as strategic or tactical means, in particular to protect themselves from an attacker or inflicting damage in the context of an action offensive, or even as a means of pressure or propaganda. We must therefore establish urgently a water market system (under the conditions identified through the study) to optimize the use of water resources and deal with issues related to water consumption especially those with an environmental character.
In general, economic growth involves the development of agriculture, industry and urban development while raising the issue of water consumption (quantitative aspects) and achieved might be brought its quality (discharges of polluted effluents)
Some either contain an estimated 1-16% of water withdrawn in the river is used for irrigation, industry and drinking water. Such samples can complete drying up of rivers. Furthermore, excessive pumping for drinking water supply of large cities located in coastal area (like Casablanca) caused the intrusion of salt water into the deeper aquifers.
In addition, the irrigated areas are growing in the world. Estimated at about 48 million hectares in early in the century, they have quintupled to 240 million today. Irrigation thus remains the very large majority of use sector in the world (70% of the amount of water used).
Waste is further increased because as a rule irrigating rarely pay more than a fifth of public programs operating costs of irrigation and also crops are heavily subsidized. And that is where lies the importance of the introduction of water markets to fight against the challenge of environmental degradation.
The water appears increasingly as a strategic issue generator conflicts between states, largely dominated by the balance of power in the absence of a true international water law; in other words, how can Morocco dominate the hydro international conflicts so as not to be affected by these problems? This question its legitimacy because of the ambiguity of international water law and from there we can ask the question: is there an international water law?
3800 acts, declarations, treaties are bilateral and multilateral succeeded in the field of the use of water resources, with an upsurge in the nineteenth century because of the growing number of state entities.
More than 286 treaties currently in force, however, concern that 61 of the 200 international river basins. A number of principles have been developed by both international custom (not undertake developments that could have harmful and lasting consequences at the expense of other states, use of shared resources ...) and by the general principles of international law (obligation not to abuse

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his rights, rules of good neighborliness) and case law (principle of community of interest between riparian states, the limited territorial sovereignty).

All times uses other than navigation and hydropower generation are playing an increasingly important role. Indeed, a growing number of treaties and agreements is about the fight against pollution and the many uses including flood control.

Without naivety to claim that the existence of law sufficient to prevent states. To resort to war, the international community must apply to advance the integration process uses accelerating the ratification of these treaties. Indeed, the problems must be solved primarily in the major hydro conflict zones (Middle East and Central Asia). Fortunately Morocco does not belong to these areas so far, but it may be in hand when the world conflict is growing on the water resource.

Principle 24 of the Declaration of the United Nations Stockholm Conference on the Environment (1972) states that international issues relating to the protection of the environment should be addressed in a spirit of cooperation by all countries, big or small, on an equal footing. Cooperation through multilateral or bilateral agreements or by other appropriate means is essential to effectively control, prevent, reduce and eliminate adverse environmental effects resulting from activities conducted in all areas and in the respect of the sovereignty and interests of all States.

There is no doubt that, within the means it is given and is based on the objectives it is drawn, Morocco has gradually been able to contribute to the advancement of international law environmental protection (including water occupies the largest share of importance) notably during the past decade. Without being able, for lack of sufficient factors, the crediting of a real strategy at this level, which would clearly define its regard to the promotion of international law policy, it may nevertheless, on the basis of practice who hitherto been hers in this matter, some general observation, that further research may later qualify and refine

So you have to go on the one hand to the selective support to some binding legal instruments and other part in a progressive adherence to mandatory legal instruments on the conservation of the environment in general and in particular water resource

So sharing vital water resources to ease tensions between countries requires joint management of storage and transport infrastructure, provided that the transfer of water between surplus and deficit basins will tend to s' increase. This management should be patrimonial way, somehow condominiums.

The relative failure of international water markets (Water marckets) given the very specific nature of this property implies that we make greater use of the concept of taxation at the level of the river basin or region to pay water at a fair price, that is to say that the lack of internal water resources market is the main cause of this failure, which is also due to the establishment of management bodies financially autonomous levying taxes at the level of the basin or catchment area.

Indeed, the ability of the international community to respond to impose a more equitable distribution of water resources, will depend in large part for the maintenance of global food security.

So we can say that all the instruments that was mentioned above and after empirical verification are difficult to use for the management of irrigation water. At this level several constraints are necessary:

The scarcity of water, large interannual variations

The pricing on possible due to the low income of many farmers

The novelty of the adoption of modern irrigation perimeter already contributing largely to under-utilisassions water and equipment, must be an incentive

Waste is favored by the dominant irrigation technique submersion.

In addition, the financing of the management function of the irrigation network is the subject of an ambiguity that pervades relations in the trio of the users of irrigation water, the Office and the authorities represented by the Ministry of Finance.

Users find that the price of water is too high and wish her downward revision!, ORMVA, having the calculations of the cost of water, proclaims that the currently practiced sales price is well below the cost and the Ministry of Finance estimates that the supply of agricultural development must consider irrigation producer. This production must be managed so that the offer made sufficient revenue to enable it to finance at least its operating budget.

And in the end, we can say that Morocco has a coherent legislative sometimes ingenious device but unimplemented, which has negative consequences: waste of water, low recovery by the State of its investments, unsupported costs operation by the user. An under pricing, which goes to the non-pricing is in addition to the direct subsidy, an indirect government subsidy to big farmers, the main beneficiaries of investments, they do not have to bear the amortization .