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ECONOMETRIC ANALYSIS OF CEREAL DEMAND IN MOROCCO USING THE ALMOST IDEAL DEMAND SYSTEM MODEL

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Abstract

Following up the agricultural policy in Morocco and enforcing it, the new strategy Green Morocco Plan (GMP) launched in 2008 also stressed on the cereals' supply. Meantime, despite their significant nutritional role, little attention has been paid to the demand side. This paper intends to perform an econometric analysis of the demand of five main cereals - Common wheat, Durum wheat, Barley, Corn and Rice- using a linear version of the flexible Almost Ideal Demand System (LA/AIDS model). A Seemingly Unrelated Regression (SUR) approach has been applied to the demand system equations with annual data covering the period from 1980 to 2015. At the overall, regular econometric restrictions (stability, structural separability, validity, etc.) have been respected our results suggest that the relations of complementarity or substitution are not determining in the cereal bundle in Morocco. Also, the Moroccan consumer behavior is characterized by a strong sensibility towards common wheat price's changes and by a difficult access for the durum wheat as it is considered as luxury good.

Keywords: *Cereals, LA/AIDS demand system, Morocco*
Jel Codes: *Q11, Q18, Q19, R15*

1. Introduction

The productivity approach of the Green Morocco Plan (GMP) and the economic openness towards the world market aim at ensuring the cereals food security in Morocco. Indeed, such a challenge has become among the most determining for the country, since cereals sector stands for the backbone of the Moroccan agro-food system either on the supply as well as on the demand sides. Imports are necessary to cover the consumer needs; cereal import bill accounted for 36% of total agricultural imports in value terms in 2014[1]. This is because the domestic supply is significantly conditioned by the rainfall performance.. On the other hand, the annual demand reaches 200 kg per capita which overpasses the world average with 152 kg per capita[2]. It should be noted that this spectacular gap in cereal demand is due not only to an expanding population, but also to the Moroccan consumption model, which gives cereals a special position.

The sensitivity of these strategic staples means that the government has to play a continuous role of market surveillance. The National Soft Wheat Floor[3] is especially concerned with a consumption price subsidy that amounted to 2.2 billion dirhams in 2014[4].

Like previous agricultural policies, the GMP launched in 2008 has also focused on the supply and price policy. This strategy aims at reducing the acreage allocated to cereals by 20%, improving productivity by 50% and reducing imports by 15 to 20% by 2020. However, little attention has been paid to the demand side patterns.

Within this context, this paper is a contribution to the cereal demand analysis in Morocco. In other words, we are interested in understanding how consumers of cereals respond to changes in prices and income and, consequently, adjust their demand. Thus, we model the relationship between the shares of expenditure reserved for each cereal, the prices of each and the total expenditure of the cereals bundle. Through this estimated model, we will obtain the values of the price elasticities, the cross price elasticities and the expenditure elasticities, which will allow us to decide on the type of each commodity. These results will be of great value to policy makers and analysts, as they will determine the effect of a possible removal of the consumer subsidy on soft wheat. Therefore, we will formulate recommendations that can be taken into consideration to better guide the action of the State on this subject.

The review of the literature shows that several studies have applied the AIDS model to estimate cereal demand (Abdelrahman, 1990; Huang and David, 1993; Tchabletienne, Koffi-Tessio and Diagne, 2010; Alam, 2011), in the case of Sudan, Asia, Togo and Bangladesh. In the Moroccan context, few research papers have applied the AIDS model in the agri-food sector (e.g. Mdafri and Wade Brorsen, 1993; Sayouti, 2014). In this sense, the present work has the originality of examining the demand for a basket made up exclusively of cereals (soft wheat, durum wheat, barley, maize and rice), by using the linear version of the AIDS model and involving nominal data at first and real data at a later stage.

The first part of this paper is devoted to the theoretical framework of the study. The second part looks at the presentation of the results of the estimates made and the interpretation of the obtained figures.

2. Methodological Approach

2.1. Model Description

The literature related to demand modeling is very broad. Generally, the two flexible functional forms intensely used in the analysis of demand behavior, especially in the field of agricultural economics are: the Rotterdam model[5] and the AIDS model[6]. Although several characteristics are valid for both functional specifications, the AIDS model seems more suitable for modeling our system of demand equations. Indeed, according to Deaton and Muellbauer (1980), the AIDS model has the advantage of:

- Allowing a first-order approximation of any demand system,
- Respecting the axioms of choice of the consumer perfectly,
- Presenting a functional form consistent with the budget-consumption survey data,
- Satisfying the zero degree homogeneity restrictions of demand functions at the income and price level, and symmetry, by imposing linear restrictions on the fixed parameters of the model,
- Agreeing with welfare analyzes given the model's correspondence to a well-defined preference structure.

According to Deaton and Muellbauer (1980), the linear version of the AIDS model is specified as follows:

$$W_{it} = a_{it} + \sum_j^n g_{ij} lnp_{jt} + b_i ln\left(X_t/P_t\right) + u_{it} \quad (1)$$

W_{it}: Represents the budget (expenditure) share of soft wheat, durum wheat, barley, maize and rice in the goods bundle, with:

P_{jt}: represents the nominal price of the cereal j;

X_t: is the total nominal expenditure per capita on the system of the five cereals a_{it} : is the constant coefficient of the share equation for soft wheat, durum wheat, barley, maize and rice respectively.

g_{ij} and b_i : are the parameters of the model that will be estimated and used for calculating the elasticities later.

$ln(P_t)$ represents the Stone index whose expression is defined as follows:

$$lnP^* = \sum_i^n W_i lnP_i \quad (2)$$

In order to ensure conformity with the restrictions of the consumer theory and to establish a maximization of the utility function, the system of demand equations must be estimated under three distinct constraints:

- ✓ Homogeneity is satisfied if and only if, for all i: $\sum_i^n g_{ij} = 0$ (3)
- ✓ Symmetry: $g_{ij} = g_{ji}$ (4)
- ✓ Additivity: $\sum_i^n a_i = 1$; $\sum_i^n g_{ij} = 0$; $\sum_i^n b_i = 0$ (5)

It is to be noted that total expenditure is used here as proxy of income; this implies that income elasticities are approximated by expenditure elasticities.

In this study, price and income elasticities will be calculated from the estimated parameters of the LA / AIDS model using the mathematical formulas of Jung (2000) as follows:

Uncompensated / Marshallian elasticity:

$$e_{i,t} = -d + (g_{i,t}/\overline{w}_{t,i}) - b_i\,(\overline{w}_j/\overline{w}_i) \quad (6)$$

Income elasticity:

$$h_i = 1 + (b_i/\overline{w}_i) \quad (7)$$

Where d is the kroenecker index with d = 1 for i = j; d = 0 for i ≠ j. The average budget share is represented by $\overline{w}_t$. The coefficients $g_{i,t}$ and b_i are the parameters estimated.

3. Data

Several economists have applied and adapted the AIDS model in different contexts and today it is also the case in our work, using the linear version of this functional form for the estimation of cereal demand in Morocco. Indeed, our demand system is compound of five equations corresponding to the estimate of the expenditure shares. Empirically, only four equations are estimated; while the fifth is deduced through the additivity restriction.

It is important to note that almost the same parameters are involved in the five equations. So, there is dependence between the residues of our model. In order to take into account the possibility of a correlation between the error terms that may bias our estimates, we used the Seemingly Unrelated Regressions (SUR) method, developed by Zellner (1962).

According to Benoit and Hyungsik (2006), this method has the advantage, first, of gaining estimate efficiency by combining the information on the different equations and, secondly, imposing / testing the restrictions implied by the parameters in the different equations.

In order to achieve the objectives already mentioned, and in view of the constraints of this study, the following working assumptions have been taken into account:

- ✓ The total expenditure is used as income proxy;
- ✓ The quantities consumed per capita were approached through the domestic availability per inhabitant, under the assumption of that inter annual inventory variations are small for every cereal;
- ✓ The data concerning the quantities demanded annually are representative of the behavior of an average Moroccan consumer. In other words, the differentiation of demand by socioeconomic class and by geographical area (urban / rural) was not taken into account.

The data needed to estimate the LA/AIDS demand system are annual series, covering the period from 1980 to 2015. They are extracted from the database of the National Office for Cereals and Legumes, the Exchange Office, the Directorate of Strategy and Statistics, the High Commission for Planning and FAO.

The modeling approach uses Eviews software to check the statistical properties of the variables included in the model, and to estimate the linearly independent demand system of common wheat, durum wheat, barley and corn. It begins first by carrying out the preliminary tests (Stationarity test, Structural stability test, Low preference separability test), to ensure efficient use of the annual time series covering the relevant period. The second step presents the estimates' outcomes and their interpretation and comparison with those obtained by the Statistics Directorate (2002) and Bossoh (2012).

Table 1. Estimate results (Nominal prices)

Parameters	**Soft wheat i=1**	**Durum wheat i=2**	**Barley i=3**	**Maize i=4**	**Rice i=5**
a_i	0,402*** (17,37)	0,176*** (6,472)	0,301*** (12,99)	0,05*** (6,07)	0,071+ (1,64)
g_{i1}	**-0,111* (-1,87)**	0,093+ (1,425)	0,036 (1,204)	-0,006 (-0,314)	-0,011 (-0,12)
g_{i2}	0,093+ (1,425)	**-0,002 (-0,024)**	-0,064* (-1,81)	-0,028 (-0,832)	0,002 (0,019)
g_{i3}	0,036 (1,204)	-0,064* (-1,81)	**0,041+ (1,339)**	-0,017+ (-1,544)	0,004 (0,083)
g_{i4}	-0,006 (-0,314)	-0,028 (-0,832)	-0,017+ (-1,544)	**0,053*** (2,472)**	-0,0009 (-0,019)
g_{i5}	0,071+ (1,64)	-0,011 (-0,12)	0,002 (0,019)	0,004 (0,083)	**0,005 (0,03)**
b_i	0,10*** (5,232)	0,066*** (2,746)	-0,147*** (-7,143)	-0,048*** (-6,597)	0,021 (0,5621)
Year_2006				0,026*** (2,633)	
R^2	0,506	0,32	0,612	0,795	
DW	2,038	1,33	1,558	1,98	
W (average)	0,517776	0,2506	0,140747	0,0799	0,010977

Notes: (***) Highly significant (α = 1%), (**) significant (5%), (*) weakly significant (10%), (+) Lower significance (20%). Values in parentheses are Student's (t-Student) ratios.

4. Results and Interpretations

Econometric results using respectively nominal and constant prices are depicted in table1. They have been obtained taking into account theoretical conditions regarding the stationarity,

structural stability and low separability preference tests, the coefficients of determination of the demand system equations, the Durbin and Watson statistics, the Student's test values, as well as the signs of the calculated elasticities. These conditions are ne necessary to reinforcing the reliability of our results. (See tables 1 and 2)

Table 2. Estimate Results (constants prices)

Parameters	Soft wheat i=1	Durum wheat i=2	Barley i=3	Maize i=4	Rice i=5
a_i	0,189 (0,951)	-0,041 (-0,191)	0,268+ (1,303)	0,355*** (5,139)	0,229 (0,042)
g_{i1}	**-0,0498** **(-0,821)**	0,116*** (2,198)	-0,022 (0,526)	-0,025 (-1,23)	-0,019 (-0,220)
g_{i2}	0,1169*** (2,198)	**-0,040397** **(-0,595)**	-0,094*** (-2,658)	-0,005 (-0,193)	0,023 (0,24)
g_{i3}	-0,022 (0,526)	-0,094*** (-2,658)	**0,097***** **(2,46)**	0,010 (0,843)	0,008 (0,132)
g_{i4}	-0,025 (-1,23)	-0,005 (-0,193)	0,010 (0,843)	**0,026+** **(1,416)**	-0,006 (-0,17)
g_{i5}	-0,019 (-0,220)	0,023 (0,24)	0,008 (0,132)	-0,006 (-0,17)	**-0,004** **(-0,032)**
b_i	0,08*** (4,01)	0,099*** (4,558)	-0,106*** (-4,387)	-0,0587*** (-8,005)	-0,015 (-0,374)
R^2	0,41	0,39	0,432	0,75	
DW	1,304	1,349	1,157	1,755	
W (average)	0,517776	0,2506	0,140747	0,0799	0,010977

From the economic point of view, the results show that it is the expenditure elasticities and the own price elasticities that determine the model of cereal consumption. Clearly, cross-price elasticities are all below unity and, generally, do not differ statistically from zero, indicating that our cereals are neither strong substitutes nor complements. (See tables 3 and 4).

Regarding elasticity estimates, we remain cautious about the use of elasticities calculated in nominal terms. Indeed, the change in cereal demand measured by current prices is disrupted by price changes themselves. This could explain the surprising value of the expenditure-elasticity of soft wheat in nominal terms which is 1.2 (see table 3), when it is known that this cereal is not a luxury good so its elasticity expenditure must not exceed unit. Therefore, it is better to develop our analysis of the behavior of the Moroccan cereals consumer, based on the results in real values. In fact, the estimates using the prices deflated by the general index of consumer prices led to the following observations.

Firstly, the durum wheat demand shows high price elasticity. Indeed, we notice a very pronounced sensitivity to the price variation with own-price elasticity of the order of (-1.26) (see table 4). By reading the real value of the expenditure elasticity (1.4) (see table 4), it appears that durum wheat could be considered as a luxury good. It means that the Moroccan consumer should not be satisfied with the quantities usually consumed in durum wheat, and therefore any improvement in his income would increase his demand for this foodstuff. Moreover, this observation could be explained, initially, by the high prices of durum wheat compared to the rest of cereals, estimated on average at 314 Moroccan dirham (dh)[1]/ql during the last decade while the soft wheat price was around 250 dh/ql. Despite its staple food status,

[1] Moroccan dirham equals 0,091 Euro in average.

nutritional value and role in the cereal season, durum wheat is not supported by the government, compared to the soft wheat which takes advantage from a farmer reference price[7], a storage premium and a consumer subsidy for the national soft wheat flour

Table 3. Nominal Elasticities

	Soft wheat j=1	**Durum wheat j=2**	**Barley j=3**	**Maize j=4**	**Rice j=5**	**Expenditure elasticity**
E_{1j}	**-1,32*** (-11,30)**	0,128 (1,009)	0,04 (0,696)	-0,029 (-0,377)	-0,024 (-0,132)	1,208*** (30,30)
E_{2j}	0,2 34 (0,881)	**-1,076*** (-2,768)**	-0,295** (-2,073)	-0,136 (-0,985)	0,007 (0,013)	1,3*** (13,04)
E_{3j}	0,801*** (3,53)	0,216 (0,85)	**-0,558** (-2,28)**	-0,041 (-0,505)	0,045 (0,111)	-0,05 (-0,345)
E_{4j}	-0,234 (0,889)	-0,270 (-0,478)	-0,135+ (-0,94)	**-0,276 (-1,01)**	-0,005 (-0,008)	0,39*** (4,206)
E_{5j}	-2,08 (0,233)	-0,27 (-0,023)	0,151 (0,029)	-0,244 (-0,056)	**-0,541 (-0,03)**	2,98 (0,845)

Notes: (***) Highly significant (α = 1%), (**) significant (5%), (*) weakly significant (10%), (+) Lower significance (20%). Values in parentheses are Student's (t-Student) ratios.

Table 4. Real Elasticities

	Soft wheat j=1	**Durum wheat j=2**	**Barley j=3**	**Maize j=4**	**Rice j=5**	**Expenditure elasticity**
E_{1j}	**-1,18*** -9,86**	0,187* (1,811)	-0,0644 (-0,955)	-0,0607 (-0,784)	-0,04 (-0,23)	1,1*** (25,67)
E_{2j}	0,2603 (1,199)	**-1,261*** (-4,639)**	-0,433*** (-3,042)	-0,052 (-0,486)	0,088 (0,227)	1,4*** (16,005)
E_{3j}	0,232 (0,886)	0,010 (0,042)	**-0,201 (-0,822)**	0,135+ (1,5016)	0,069 (0,15)	0,25+ (1,435)
E_{4j}	0,066 (0,258)	0,118 (0,347)	0,235+ (1,497)	**-0,607** (-2,576)**	-0,078 (-0,153)	0,27*** (2,887)
E_{5j}	-1,105 (-0,131)	2,459 (0,276)	0,972 (0,164)	-0,521 (-0,139)	**-1,435 (-0,102)**	-0,37 (-0,101)

Secondly, the soft wheat demand has met the expectations with respect to its expenditure elasticity, which is (1.1) (see table 4), but it has displayed a price elasticity that exceeds the unit in absolute terms. This high sensitivity of common wheat to price changes reflects, on one hand, the reason why this cereal has always been the common denominator of all cereal policy. On the other hand, it shows that the reform of wheat policy, which is likely to have an impact on the price, would have a significant effect on the demand for this product. Consequently, we could argue that with the maintenance of the reference price, in a context of trade liberalization, the consumer subsidy could only be maintained.

Thirdly, it is interesting to develop the analysis for the other cereals, namely barley, maize and rice. Based on the results of the estimates, it turns out that barley and maize behave as commodities with actual values of expenditure elasticities of the order of 0.25 and 0.27 respectively (see table 4). As for rice, it displays an expenditure elasticity that does not differ statistically from zero, this could be explained by the fact that the demand for rice in Morocco

is negligible compared to other cereals. Indeed, it does not exceed 0.4% of total cereal demand on average over the last ten years.

5. Conclusion

This paper has shown that the pattern of cereal consumption in Morocco is defined mainly by the price elasticities and the expenditure elasticities. Indeed, the calculated cross prices elasticities are all below unity and generally do not differ statistically from zero. In other words, the relations of complementarity or substitution are not decisive in the cereal basket in Morocco.

Based on the results of the estimates, it turns out that barley and maize behave as commodities with actual values of expenditure elasticities of the order of 0.25 and 0.27 respectively. These results are in perfect agreement with what was obtained by the Directorate of Statistics (2002) and Bossoh (2012) with respective spending elasticities of 0.63 and 0.6. Still in relation to barley and maize, we add that only the latter displays a price elasticity that is significant at the 5% threshold and in the range of 0.6 in absolute terms. A result that elucidates the economic theory that food goods generally have inelastic demand.

This study also showed that the Moroccan consumer displays a strong sensitivity to changes in the price of common wheat. This underlines the need of maintaining the regulatory system for common wheat but, at the same time, opens the debate on the ways of reforming the system of the consumption compensation based on the Common wheat floor subsidy. As for durum wheat, the high price sensitivity of its demand and its category as a luxury good explain why the access to this cereal is difficult for an average consumer.

Consequently, in light of the above outcomes, we suggest the following recommendations:

- Focus on the quality of the domestic wheat supply, to produce the varieties demanded by the industrial mills and, thus, reduce the volumes imported from abroad;
- Consider a differentiation policy to support production proportional to the quality of locally produced wheat;
- Improve the productivity of durum wheat to reduce production costs and, then, lower prices that can stimulate domestic demand for this high-nutritious cereal;
- Maintain the regulatory mechanisms of the soft wheat sector, and improve the subsidy system for domestic flour by strengthening the control of national flour prices;
- Continue investigations in this research area by modeling cereals demand along with other food products.

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