7 A Welfare Analysis of the Price System Reforms' Effects on Poverty in Tunisia

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Introduction

Throughout the 1980s, the Tunisian economy has faced a deterioration of its external and internal deficits. The reason behind such deterioration may be partly attributed to the rapid consumption growth and to the subsidization of consumer prices which has been the main cause of the budgetary deficit. This situation led the government to adopt the structural adjustment plan proposed by the International Monetary Fund in 1986. This plan involved reforms aimed at the restructuring of the economy so as to enhance the traded goods sector, the rehabilitation of market mechanisms and the encouragement of private initiatives. These objectives were to be accomplished partly through the liberalization of the price system and through a fiscal reform with mainly the institution of the value added tax in July 1988. The goal of these reforms was to promote a sustainable economic growth without internal and external deficit deterioration. Nevertheless, macro-economic adjustment programs have often raised anxiety concerning their effects on poor population. The welfare reforms' effects on poor population have then to be evaluated. It is necessary to analyze the microeconomic implications of these macroeconomic reforms to be able to target correctly those social categories that need protection and identify the social measures that would have to accompany such reforms.

The aim of this paper is to propose a methodology, consistent with the consumer theory, that allows the evaluation of the implications of the price system reforms on the poor population's welfare. This issue poses an identification and a measure problem. It also delves on the poverty line estimation, using a utilitarian approach and the definition of the poor population welfare measures, that allow the assessment of social loss subsequent to the presence of poor people having an income level inferior to the poverty line. Welfare measures advocated in this paper are based on King's approach (1983). This approach presents the advantage of

considering the households' reaction to price system reforms. It is based on the estimation of a demand system that has to respect economic consumer axioms. A methodology is presented allowing to estimate parameters of a flexible demand system, as the QAIDS system of Banks *et al*. (1993). The parameters estimation of this model have been made possible using the National Statistic Institute households' budget and consumption survey of 1990. The simulation of a price system reform's effects on the poor population and the identification of target groups is addressed. Within the framework of this section, a hypothetical reform is considered consisting of eliminating the budget devoted to food subsidies. The impact of this reform on the poor population welfare is examined and the possibility of reallocating a part of this budget to better tackle the poverty issue in Tunisia. Socio-demographic indicators are defined which are likely to lead to a better targeting of the poor populations. Such targeting would make it possible to reduce public expenditures and also to improve the well-being of these target groups.

Poor Population Welfare

The economic literature dealing with poor population welfare measures has considerably increased since the work done by Sen (1976). According to Sen, poverty analysis requires the solving of two problems, namely that of identification and that of aggregation. The identification problem consists in being able to spot the poor out of the total population with the definition of a poverty line (PL). It is also necessary to identify the sensitivity of the PL to price system reforms to establish a relationship between structural adjustment reforms and their microeconomic effects. The aggregation problem consists in finding a means through which the distribution of the individual well-being is moved to an aggregated poverty measure. This measure could be interpreted as being the social loss due to the presence of individuals having an income level lower than the PL. It would be preferable to see that this measure is consistent with certain axioms developed in the literature studying this subject.

The Identification Problem

The identification of the poor population, with the estimation of the PL, is a necessary step in analyzing the adjustment reforms on the well-being of the poor population. One of the methods commonly used consists in estimating this PL on the basis of needs in food energy (Greer and Thorbecke, 1986 ; Charmes, 1990). The shortcoming of this approach is that it does not account

for all the needs created by society. A better alternative would be to derive the PL from the consumer theory (Ravallion, 1996).

The determination of the PL is rarely formulated in utilitarian terms. In theory, a utilitarian approach should enable the estimation of the PL corresponding to a minimum utility level, or again to an indifference curve that delimits the welfare level of a poor individual from the welfare level of a non-poor individual. The compensated expenditure function would allow therefore to determine for any given price system, the minimum expenditure level required to reach this indifference curve. As an example, the individual welfare may be represented by the Stone-Geary utility function $U(x) = \prod_i (x_i - \overline{x_i})^{\sigma_i}$, where x_i is the quantity consumed of good *i*, σ_i is a positive parameter and $\overline{x_i}$ may be interpreted as some minimum consumption of good *i*; the maximization of this utility function subject to budgetary constraint $\sum_i p_i x_i = Y$, where p_i is the price of good *i* and *Y* is the income level, gives the following non-compensated expenditures functions : [2]

$$d_i^h = z_i + \sigma_i \ (Y^h - z) \quad \text{with} \quad \sum_i \sigma_i = 1 \qquad (1)$$

where d_i^h is the per equivalent adult expenditure of good *i* by household *h* having a per equivalent adult income level, Y^h, and z_i is the constant of the model that indicates the minimum per equivalent adult expenditure of good *i*[3] Bourguignon and Field (1997) have underlined that when using this model to study the consumption behavior, it has to be assumed that all individuals having an income level below the minimum, $z = \sum_i p_i \overline{x}_i$, required to buy the minimum bundle ($\overline{x}$), may be considered as being poor. Nevertheless, the definition of the poverty as compared to a reference bundle ($\overline{x}$) is too restrictive especially if a utilitarian approach is adopted for the estimation of the PL.[4]

A better approach is to choose another demand system that is more flexible. If $e(p,U)$ denotes the expenditure function which defines the minimum expenditure necessary to attain a specific utility level *U* at given price system *p*, a first order approximation to any demand system that satisfies axioms of the consumer theory, can be given by the PIGLOG class definite:

$$\ln\big(e(p,U)\big) = (1-U)\ln\big(z(p)\big) + U\ln\big(g(p)\big) \qquad (2)$$

Save a few exceptions, the utility level U lies between 0 (the subsistance level) and 1 (the bliss level).[5] So the functions $z(p)$ and $g(p)$ can be regarded as the costs of subsistance (or the PL) and bliss, respectively. For the AIDS demand system of Deaton and Muellbauer (1980a) or QAIDS of Banks a*t al*. (1993), the z(p) function takes the following form:

$$\ln z(p) = \ln(\omega_0) + \sum_{i=1} \omega_i \ln(p_i) + \frac{1}{2} \sum_{i=1} \sum_{k=1} \theta_{ik} \ln(p_i) \ln(p_k) \quad (3)$$

The AIDS or QAIDS demand system estimation does not allow to deduce a PL if a value of ω_0[6] is not first estimated. Since ω_0 can be interpreted as the PL if all prices are equal to 1, an arbitrary specification of this value can lead only to an arbitrary estimation of the PL . Thus, the recommendation made by Banks *et al*. (1993) is followed which suggests specifying a plausible interval for this parameter. This allows the avoidance of controversies concerning the estimation of the PL since the analysis of the price system reforms on the poor population will be made using a large interval of PLs. To do this, Atkinson's stochastic dominance conditions (1987) is used to evaluate the reforms impact on the welfare distribution of poor population with the use of a large interval of PLs.

The Aggregation Problem

To solve the aggregation problem, a mapping from the individual welfare distribution into a scalar poverty measure is required. The poverty measure which meets analysis needs must satisfy axioms of monotonicity, transfer, transfer-sensibility and decomposability.[7]

- The Monotonicity Axiom - A reduction of the poor's income must increase the poverty measure, all things being equal.
- The Transfer Axiom - An income transfer from a poor individual to a less one must increase the poverty measure, all things being equal.
- The Transfer-Sensibility Axiom - For any positive integer ρ and any pair of poor individuals h and j, if $j > h$, then $\Delta P^{h,\, h+\rho} > \Delta P^{j,\, j+\rho}$ where $\Delta P^{h,\, h+\rho}$ is the increase in poverty measure due to an income transfer from the hth poor to the $(h+\rho)$th poor.
- The Decomposability Axiom - Let Y^f be a vector of incomes obtained from Y by changing the incomes in subgroup c from Y_c to Y_c^f, where the total number of households in subgroup c (H_c) is unchanged. If Y_c^f has more poverty than Y_c , then Y^f must also have a higher level of

poverty than Y. The class of poverty measures proposed by Foster et al. (1984) and retained for this work satisfy all these axioms. It takes the next form:

$$P_{\alpha}(z,Y)=\frac{1}{H}\sum_{h=1}^{H_p} n^h\left(\frac{z-Y^h}{z}\right)^{\alpha} \qquad (4)$$

where z and Y are as defined above, H (H_p) is the total number of households (poor households), n^h is the size of household h and α may be considered as a measure of poverty aversion: a larger α gives greater emphasis to the poorest poor. As α becomes very large, P_α approaches a Rawlsian measure which considers only the poorest households' welfare. The measure P_0 is known as the headcount ratio, while P_1 is a normalized average gap measure which is a good poverty measure only if all the poor have the same income.[8] The poverty measure P_α satisfies the monotonicity axiom for $\alpha > 0$, the transfer axiom for $\alpha > 1$, the transfer sensitivity axiom for $\alpha > 2$ and always the decomposability axiom.[9]

The decomposition of poverty measure is very useful since economic policies may have different impact on subgroups that compose the poor population. Also, a precise knowledge of the reforms' impact envisaged on the different subgroups will allow to identify better the most vulnerable social groups necessary to protect and social measures required that have to be inherent to these reforms. Thus, if C is considered to be mutually exclusive subgroups, if $P_{c,\alpha}$ is the poverty measure in the subgroup c and if f_c represents the weight of the subgroup c in the total population, then the measure P_α may be decomposed as follows:

$$P_{\alpha}(z,Y)=\sum_{c=1}^{C} f_c\, P_{c,\alpha}(z,Y_c) \qquad (5)$$

To compare the levels of a household's welfare when it faces different price systems, it is equally necessary to define a welfare measure to each poor household. This measure may be presented in terms of values of the equivalent income function as defined by King (1983). For a given budget constraint (p, Y), equivalent income is defined as the income level which allows, at the reference price system p^r, the same utility level as can be reached under the given budget constraint:

$$V(p^r,Y_e)=V(p,Y) \qquad (6)$$

where V is the indirect utility function and p is the price system. Notice that since p^r is fixed across all households, Y_e is an exact monetary metric of actual utility $V(p,Y)$ because Y_e is an increasing monotonic transformation of $V(.)$. Indeed, inverting the indirect utility function, equivalent income is obtained in terms of the expenditure function:

$$\begin{aligned} Y_e &= e\left(p^r; V(p,Y)\right) \\ &= y_e(p^r, p, Y) \end{aligned} \tag{7}$$

where $e(.)$ is the expenditure function and $y_e(.)$ is the equivalent income function. The properties of the equivalent income function are derived from the properties of indirect utility and expenditure functions. Also, $y_e(.)$ is increasing in p^r and Y, decreasing in p, homogeneous of degree 1 in p^r and , homogeneous of degree 0 in (p, Y).

Suppose that the reference price system p^r is equal to the actual price system p^a , the distribution of equivalent income per equivalent adult in the actual situation (Y_e^a) is equal to the actual distribution of the income Y:

$$Y_e^a = y_e(p^a, p^a, Y) = Y \tag{8}$$

Suppose that the reform consists in substituting the price post-reform system p^p to the current price system p^a, the post-reform equivalent income Y_e^p would be given by:

$$Y_e^p = y_e(p^a, p^p, Y) \tag{9}$$

The post-reform equivalent income Y_e^p is a monetary assessment of utility level $V(p^p, Y)$ subsequent to the substitution of the price system p^p to the price system p^a. A natural per equivalent adult welfare measure variation of each household may be given by the change in equivalent income:

$$\begin{aligned} \Gamma &= y_e(p^a, p^p, Y) - y_e(p^a, p^a, Y) \\ &= Y_e^p - Y \end{aligned} \tag{10}$$

Also, according to Equation 8, the PL z evaluated under the price system p^a corresponding to the equivalent PL z_e that allows reaching the utility level V_z in the current situation, characterized by the couple (p^a, z), and in the post-reform situation, characterized by the couple (p^p, Y_z):

$$\begin{aligned} &V_z(p^a, z_e) = V_z(p^p, Y_z) \\ &z_e = y_e(p^a, p^p, Y_z) \end{aligned} \tag{11}$$

where V_z corresponds to the minimum utility level required to be non-poor and Y_z is the per equivalent adult PL correponding to the price system p^p. If the reform increases the price of some goods, households whose per equivalent adult income is between z and Y_z in the current situation will become poor people in the post-reform situation, given that the reform implies for them an equivalent gain (negative) per equivalent adult equal to:

$$\begin{aligned} \Gamma &= y_e(P^a, P^p, Y_z) - y_e(P^a, P^a, Y_z) \\ &= z_e - Y_z \end{aligned} \tag{12}$$

The impact of macroeconomic reforms on the welfare of poor population may be evaluated by substituting in the retained poverty measure FGT Y_e and z_e to Y and z. [10] The poverty measure FGT in the actual situation and in the post-reform situation will then be given by the following equation:[11]

$$\mathrm{P}_\alpha^o(z_e, Y_e) = \frac{1}{H}\sum_{h=1}^{H_p^o} n^h \left(\frac{z_e - y_e(p^a, p^o, Y^h)}{z_e} \right)^\alpha \quad \text{with} \quad o = a, p. \tag{13}$$

where H_p^o is the number of poor households in the situation o.

Thus, the analysis of the price system reforms' effects on the welfare of poor population requires the specification of an equivalent income function. This function is closely linked to the estimation of a demand system that is coherent with the consumer theory.

Specification of a Demand System

The specification and estimation of a demand system as much as possible in harmony with the economic theory, is an essential element of a welfare analysis of the price system reforms' effects. The problem is that this choice can largely predetermine the selection of a fiscal reform (Deaton, 1988).[12] With the absence of sufficiently long chronological series data on consumption at different prices of households in less developed countries (LDC), it is hard to estimate a demand system which is not additively separable, and the linear expenditure system (LES) hence becomes a natural choice. Nevertheless, for the LES and for all additively separable demand systems, income elasticities are approximately proportional to price elasticities. Consequently, goods that have a weak price elasticity and which are desirable to tax on efficiency grounds, have equally a weak income elasticity and are undesirable to tax on equity grounds (Deaton and Muellbauer, 1980b). Conversely, income elastic goods consumed by the non-poor which are natural targets for redistributive taxation, have high price elasticities and as a result, high deadweight or efficiency losses. The trade-off between equity and efficiency considerations is then given by a uniform tax structure independently of the LES parameters' estimations. The need to use the estimation results to deduce socially optimal reform directions has therefore motivated the authors to adopt a more flexible functional form, namely the QAIDS model of Banks *et al*. (1993) defined by:

$$w_i = \omega_i + \sum_k^K \theta_{ik} \ln(p_k) + \beta_i \ln(\frac{Y}{z(p)}) + \frac{\delta_i}{b(p)}[\ln(\frac{Y}{z(p)})]^2 + \vartheta_i \qquad (14)$$

$$\text{with } \sum_i \omega_i = 1, \quad \sum_i \theta_{ik} = \sum_k \theta_{ik} = \sum_i \beta_i = \sum_i \delta_i = 0 \quad \text{and} \quad \theta_{ik} = \theta_{ki}$$

where w_j, p_k, p, $z(p)$ and Y are as defined above, ϑ_j is a residual term and the $b(p)$ function is obtained according to the Cobb-Douglas form:

$$b(p) = \prod p_i^{\beta_i} \qquad (15)$$

The QAIDS system, contrary to the AIDS system of Deaton and Muellbauer (1980a), allows not only income elasticities to vary with the income level, but also a good to be a luxury to some income levels and a

first necessity good to others. This will be the case if coefficients β and δ are of opposite signs.

To a certain extent, the Deaton (1988) and Deaton and Grimard methodology (1992) is followed in estimating parameters of the QAIDS system. Statistical information contained under a double dimension to be able to develop a panel estimation data is used. The sample is then subdivided into different clusters. Each cluster contains about 20 households, characterized by a geographical proximity and surveyed during the same period. Also, as is assumed by Deaton (1988) and Deaton and Grimard (1992), households that belong to the same cluster are supposed to face the same price system. The variability between cluster prices is justified by a spatial and often a temporal effect.[13] Also, to linearize the problem of estimating the parameters of the QAIDS system, it is supposed that the PL z(*p*) and the function *b*(*p*) are exogenous.[14] Under these conditions, the budgetary equations to be estimated take the following form:

$$w_i^{ch} = \omega_i + \sum_k^K \theta_{ik} \ln(p_k^c) + \beta_i \ln(\frac{Y^{ch}}{z}) + \delta_i [\ln(\frac{Y^{ch}}{z})]^2 + \mu_i D^{ch} + f_i^c + \vartheta_i^{ch} \quad (16)$$
$$k = 1,\ldots K, \quad c = 1,\ldots C \quad et \quad h = 1,\ldots H_c$$

where H_c is the number of households in the cluster *c; D* is a vector of regional and demographic variables, whose introduction seems very relevant given that these variables can influence the consumption levels with the classic variables like the price and the income, f^c is a specific fixed effect to the cluster[15] and p_k^c is the price of good *k* that is constant within the cluster *c* and variable between clusters. The equivalent income function relative to the QAIDS system is given by this equation:

$$\ln(Y_e^{ch}) = b(p^r)\left[\left(\frac{\ln(Y^{ch}) - \ln(z(p))}{b(p)}\right)^{-1} + \delta(p^r) - \delta(p)\right]^{-1} + \ln(z(p^r)) \quad (17)$$

where p^r is as defined above (King, 1983) and the function δ(*p*) is obtained according to the Cobb-Douglas form:

$$\delta(p) = \prod p_i^{\delta_i} \quad (18)$$

However, these prices are not observable. To bypass this problem, the unit value for each good as being expenditure relative to quantity is

used as a price indicator. For each household having consumed good *k*, it is possible to calculate a unit value.[16]

Deaton (1988) has underlined that the unit values variability through the sample does not reflect only the spatial and temporal variability prices. It also reflects the quality choice that is itself a function of the price system and the income. Moreover, Deaton has developed a methodology which consists in cleaning unit values from qualities' effects and attributing their residual variability to a spatial price.[17] Furthermore, these unit values contain measurement errors coming from expenditures or quantities. Also, the use of average unit values as indicator of the price in each cluster is found to be reinforced because it allows the reduction of these measurement errors' misdeeds on estimation results.[18]

The first step consists in estimating the income, demographic and regional variables' effects by exploiting the variability within cluster of the budgetary equations. This will be done by applying the ordinary least square (OLS) on model 16 transformed by the transformation matrix *Q* defined as follows:[19]

$$Q = I - \frac{1}{H_c} SS' \tag{19}$$

where I is the identity matrix of order H_C and S is a sum vector also of order H_C; this consists in using deviated variables to their respective average in the cluster.[20] It follows that:[21]

$$\begin{aligned} w_i^{ch} - w_i^{c\cdot} = {} & \beta_i \left[\ln(y^{ch}) - \ln(y^{c\cdot})\right] + \delta_i \left[[\ln(y^{ch})]^2 - [\ln(y^{c\cdot})]^2\right] \\ & + \mu_i [D^{ch} - D^{c\cdot}] + [\vartheta_i^{ch} - \vartheta_i^{c\cdot}] \end{aligned} \tag{20}$$

This gives the estimate $\hat{\beta}_j$, $\hat{\delta}_j$ and $\hat{\mu}_j$. The second step consists in using the variability between clusters in order to identify prices' effects. To account for measurement errors that may appear in the unit values, the instrumental variable method is also applied to the next equation:[22]

$$w_i^{c\cdot} - \hat{\beta}_i \ln(y^{c\cdot}) - \hat{\delta}_i [\ln(y^{c\cdot})]^2 - \hat{\mu}_i D^{c\cdot} = \omega_i + \sum_{k=1}^{K} \theta_{ik} \ln(p_k^c) + f_i^c + \upsilon_i^c \tag{21}$$

The Hausman's specification test (1978) for the presence of measurement errors is implemented for each equation. The statistics of the test are as follows:

$$\mathrm{K} = (\hat{\theta} - \hat{\theta}_{VI})'[\hat{V}(\hat{\theta}_{VI}) - V(\hat{\theta})]^{-1}(\hat{\theta} - \hat{\theta}_{VI}) \qquad (22)$$

where $\hat{\theta}$, $\hat{\theta}_{VI}$, $V(\hat{\theta})$ and $V(\hat{\theta}_{VI})$ represent respectively the estimations of parameters' prices and their variances-covariances matrix according to OLS and instrumental variables methods.[23] Given that estimation results are used for fiscal reform analysis, it is necessary to use a demand system verifying the restrictions of the consumer theory. So, it is essential finally to impose homogeneity and symmetry constraints to the parameters of price effects.[24]

The application field of this method can only be based on food goods given that the survey conducted by the National Institute of Statistics reports expenditures only for non-food goods. Also, to insure the system's closure, the non-food budgetary equation has been omitted. Their respective parameters are deduced from constraints of additivity. The estimation of the QAIDS demand system has focused on the whole sample to improve the accuracy of the estimations.[25] Nevertheless, the urban - rural spatial dualism in the household consumption behavior has been taken into account by the specification of own price effects as follows:[26]

$$\theta_{ii} = \theta_{ii}^{0} + \theta_{ii}^{1} M^{c} \qquad (23)$$

where M^c is a dummy variable that indicates if the region of household residence belonging to the cluster *c*, is urban or rural.[27]

Table 1 presents results of the Hausman's specification tests (1978). This Table shows that at the traditional threshold of 5% for all groups of goods, the presence of measurement errors hypothesis and correlation between unit values and the cluster specific effect may be rejected.

Table 1 Specification test of Hausman (1978)

Commodities	K
Hard Wheat	5.16
Tender Wheat	2.50
Other Wheat	6.64
Vegetables	9.08
Fruit	4.18
Meat	6.41
Poultry and Eggs	6.37
Milk	5.54
Sugar	8.20
Other Sugar Products	7.16
Mix Oils	9.65
Olive Oils	4.03
Fish	7.96
Canned Foods	11.75
Other Foods	2.19

N.B. The theoretical value of Chi-square is 28.9 when the freedom degree is equal to 18. The presence of measurement errors hypothesis in unit values in the budgetary equations can be rejected.

Finally, matrix of prices elasticities provided from these estimation results are presented in Tables 2 and 3. These Tables show that all own-elasticities prices in urban and rural area are, in accordance with the economic theory, negative and statistically significant. The performance of the estimation results must be equally considered according to the concordance of cross-elasticity signs with the goods nature. It is observed that the estimation results substantiate the substitutability between the various groups of goods such as cereals groups, olive and mix oils groups, and finally between the different proteins products such as meats, fish and poultry and eggs groups. Nevertheless, some inconsistency appears in the estimation results. For example, the negative sign of the cross-elasticity between poultry and eggs and fish groups or between meat and milk groups.[28]

INSERT TABLES 2 and 3 HERE

Reform of the Price System and Identification of Target Groups

The impact on poverty of a possible food subsidy suppression through a plausible interval of poverty line and a wide range of poverty measures is analyzed. This hypothetical reform is equivalent for each poor to an income loss equal to:

$$\begin{aligned} -\Gamma^h &= y_e(p^a, p^p, Y^h) - y_e(p^a, p^a, Y^h) \\ &= Y_e^h - Y^h \end{aligned} \tag{24}$$

where Γ^h measures henceforth the per equivalent adult income loss of household h subsequent to the passage from the price system p^a to the price system p^p. The FGT class of poverty measures in the current situation and in the post-reform situation will be given respectively by equations 25 and 26:

$$\begin{aligned} \mathrm{P}_\alpha^a(z_e, Y_e^a) &= \frac{1}{H}\sum_{h=1}^{H_p^a} n^h \left(\frac{z_e - y_e(p^a, p^a, Y^h)}{z_e} \right)^\alpha \\ &= \frac{1}{H}\sum_{h=1}^{H_p^a} n^h \left(\frac{z_e - Y^h}{z_e} \right)^\alpha \end{aligned} \tag{25}$$

$$\begin{aligned} \mathrm{P}_\alpha^p(z_e, Y_e^p) &= \frac{1}{H}\sum_{h=1}^{H_p^p} n^h \left(\frac{z_e - y_e(p^a, p^p, Y^h)}{z_e} \right)^\alpha \\ &= \frac{1}{H}\sum_{h=1}^{H_p^p} n^h \left(\frac{z_e - (Y^h - \Gamma^h)}{z_e} \right)^\alpha \end{aligned} \tag{26}$$

where H_p^a and H_p^p represent respectively the number of poor households in the current and in the post-reform situation. Thus, the poverty measure variation resulting from the substitution of the price system p^p to p^a is given by the following equation:

$$\Delta \mathrm{P}_\alpha = \frac{1}{H z_e}\left[\sum_{h=1}^{H_p^a} n^h \left[\left(z_e - (Y^h - \Gamma^h)\right)^\alpha - \left(z_e - Y^h\right)^\alpha \right] + \sum_{h=H_p^a+1}^{H_p^p} n^h \left(z_e - (Y^h - \Gamma^h)\right)^\alpha \right] \tag{27}$$

The left part of the equation 27 reflects the increase in the poverty measures explained by the well-being deterioration of the population part that was and remained poor following this reform. The right part expresses the poverty deterioration due to the increase in the number of poor households.

The food subsidies suppression entails essentially an increase of 58% of the hard wheat price, 54% of the tender wheat price, 10% of the other cereals price, 16% of the poultry and eggs price, 22% of the milk price, 32% of the sugar price and 49% of mix oils price. The reform effects on the poor population welfare, for different values of aversion to the poverty, are summarized in Table 4.

Table 4 Welfare impact of the reform on poor population

α	z_e	$P_\alpha(z_e, Y_e^a)$	$P_\alpha(z_e, Y_e^p)$	ΔP_α (%)
0	250	0.1087	0.1402	28.89
1	250	0.0271	0.0366	34.89
2	250	0.0102	0.0144	41.32
3	250	0.0047	0.0069	47.05
0	290	0.1563	0.1904	21.80
1	290	0.0418	0.0543	29.75
2	290	0.0164	0.0224	36.31
3	290	0.0078	0.0110	41.75
0	330	0.2095	0.2502	19.47
1	330	0.0589	0.0743	26.19
2	330	0.0242	0.0319	32.24
3	330	0.0118	0.0163	37.45

This hypothetical reform entails, if no compensation measure is taken, an important deterioration of all poverty measures. A monetary evaluation of the welfare deterioration indicates that the per equivalent loss (Γ) per equivalent adult would be equal to 22.2 dinars. This loss corresponds on the average to 9.34% of the poor population equivalent income. In addition, the greatest losers from this reform are found among the poorest people as is indicated the growing decline of the FGT measure when the aversion to poverty increases (Table 4).

The price system liberalization constitutes for the state a necessary option to reduce its budgetary deficit since most studies have shown that in nominal terms, food subsidies profit more to the richer people. In addition, these subsidies are a source of economic distortions given the relative prices alteration they engender. This reform has to be accompanied by compensation measures to minimize its harmful consequences on the poor population. This compensation, evaluated at the current price system (p^a),

has to be at least equal to the equivalent loss per equivalent adult (Γ). If in addition, the state's objective is to eliminate the poverty problem in the post-reform situation, the budget required may be given by $H\mathrm{P}_1(z_e, Y_e)z_e$. Table 5 gives the budget share relative to the food subsidies budget, according to different choice of PLs required to eliminate all poverty in the current (B^a) and in the post-reform situation (B^p), if a perfect procedure of targeting at no cost can be used to identify the poor from the non-poor population.

Table 5 Budget share relative to subsidies budget required to eliminate poverty

Actual Situation		Post-reform Situation	
z^a	B^a (%)	$z^p = Y_z$[29]	B^p (%)
250	117.47	273	23.57
290	131.25	316	40..54
330	150.00	358	63.20

Thus, the state expenditures are considered to correspond exclusively to the budget devoted to food subsidies, its expenditures have to increase from 17.50 to 50% in the current situation to eliminate totally the poverty problem if the targeting cost of poor population is null. This course of action is not foreseeable given the tight budgetary policy which has been pursued by the Tunisian government since the adoption of the structural adjustment plan in 1986. On the other hand, the food prices liberalization would not only allow the state to have the required resources to eliminate poverty, but also help to save 36.8 to 76.43% of the budget devoted to food subsidies. Nevertheless, the success of this economic policy depends on the state's capacity to target perfectly the poor population and on the inherent costs of targeting.[30]

It is supposed that government decides to devote a part of the rise in its budgetary revenue which has resulted from the food subsidies suppression, to a program of poverty alleviation. Thus, in order to identify target groups, the state may proceed to the minimization of the FGT poverty measure subject to a budgetary constraint:

$$Min\ \mathrm{P}_\alpha(z_e, Y_e) = \sum_{j=1}^{J} f_j \mathrm{P}_{j,\alpha}\left(z_e,\ y_e(p^a, p^p, Y_j + T_j)\right) \text{ subject to } \sum_{j=1}^{J} n_j T_j = B \qquad (28)$$

where P_α, $\mathrm{P}_{j,\alpha}$, f_j, z_e, Y_e, y_e are as defined above, n_j is the individual number of subgroups j, T_j is the universal transfer in subgroup j and B is the budget devoted to the poverty alleviation program. Also, the decomposability of

the FGT poverty measure would allow the identification of the priority target groups that must benefit from the budget devoted to the poverty alleviation program. Indeed, if the state desires to increase marginally the transfer granted to an individual of the subgroup *j*, the impact of this decision would be given by:

$$\frac{\partial P_\alpha}{\partial T_j} = -\frac{\alpha}{z_e} f_j P_{j,\alpha-1} \qquad (29)$$

Equation 29 shows that if the objective is to minimize P_α at national level, groups having a strong contribution to the measure $P_{\alpha-1}$ have to be marginally favored.[31] Table 6 presents the subgroup contribution to the poverty according to various regional criteria (rural or urban zone, north or south regions...) or socio-demographic criteria (number of child by household, the occupation nature of the household head, his/her education level...).

A study of Table 6 shows that poverty is essentially a rural phenomenon in Tunisia. This problem is widespread in the northern regions and in West Central Tunisia. The targeting must also be considered according to other criteria such as the main occupation of the household head and his/her education level.

If the occupation of the household head is taken into consideration, poverty is pervasive among workers in agricultural and non-agricultural sectors. Targeting according to the main occupation of the household head may not altogether be reliable. Indeed, the poor who have activities in the informal sector may not have been included in this survey.

Finally, if targeting is to be made according to the education level of household head, illiterates have to be focused upon. As this population group is the largest for all the retained FGT measures, it may be concluded that any intervention which succeeds in better targeting, this group may entail a sensitive reduction of poverty.

Nevertheless, the targeting of poor population based on regional characteristics or socio-demographic criteria, is not without costs. Indeed, it is not excluded that an important part of the non-poor population is, for example, illiterate or residing in the rural zones. The analysis of the costs which result from such risks of errors should precede any proposal aiming at the use of these targeting procedures.

Table 6 Subgroup contribution to poverty

Contribution of subgroups (in %)		P_0	P_1	P_2	P_3
Zone	Urban	27.86	24.11	21.73	19.76
	Rural	72.14	75.89	78.27	80.24
Regions	Tunis	6.26	5.28	4.57	4.12
	North East	11.21	10.09	9.56	9.15
	North West	28.15	31.68	34.08	36.15
	East Central	6.11	5.99	5.96	6.04
	West Central	20.66	22.69	24.45	25.64
	Sfax	5.93	5.80	5.44	5.03
	South East	10.53	7.28	5.51	4.28
	South West	11.15	11.17	10.42	9.58
Profession	Inactive	11.06	11.59	12.53	13.54
	Agricultural Worker	22.67	24.61	25.77	26.72
	Agricultural	18.84	17.20	15.75	14.53
	Non-Agricultural Worker	31.60	32.15	32.50	32.63
	Non-Agricultural Independent	9.66	8.64	8.12	7.73
	Others	6.17	5.80	5.33	4.85
Education	Illiterate	70.62	73.10	74.70	75.81
	Primary	25.14	23.17	21.93	21.13
	Secondary 1st cycle	3.01	2.85	2.72	2.58
	Secondary 2nd cycle	0.92	063	0.43	0.30
	Academic	0.30	0.25	0.21	0.18

Estimation of a Plausible Interval of Poverty Lines

It has been shown that the estimation of QAIDS demand system does not allow to deduce a PL if an assessment is not identified beforehand, of the parameter ω_0 where this parameter indicates the cost of subsistence if all prices are equal to 1. Banks *et al.* (1993) propose that this parameter has to belong to a plausible interval chosen appropriatly. The Ravallion method (1994) is proposed to be used to estimate this interval.

It is both natural and convenient to decompose PL in two components: (a) food PL (z_f) and (b) non-food PL (z_{nf}). Nutritional requirements for good health are the most common approach in defining a food PL (Greer and Thorbecke, 1986; Charmes, 1990). To deduce a food PL consistent with the consumer theory, a better method would be to use a utilitarian approach. It is proposed to estimate this component of PL using a linear demand system LES.[32] To do this, it is supposed that food goods make up a group of goods separable from others.[33] This enables keeping the usage

of the LES model solely for the estimation of the food PL. Thus, the following non-compensated expenditures functions are obtained:

$$d_i^h = z_i + \sigma_i \ (Y_a^h - z_f) + \vartheta_i^h \quad \text{with} \quad \sum_i \sigma_i = 1 \qquad (30)$$

where d_i^h, z_i, z_f and σ_i are as defined above Y_f is the per equivalent adult food expenditure of household h and ϑ_i^h is a residual term. The estimation results of the model (Equation 30) using the ordinary least square (OLS) are given in the following Table 7:[34]

Table 7 Results of first stage estimation poverty line

Food Goods	Z_I	σ_i	R^2
Hard, Tender and Other Wheat	40.871	0.072	0.27
	(120)	(55)	
Vegetables	30.480	0.117	0.51
	(86)	(86)	
Fruit	7.369	0.094	0.40
	(19)	(65)	
Poultry and Eggs; Meat and Fish	40.355	0.334	0.76
	(72)	(154)	
Milk	13.536	0.095	0.41
	(39)	(71)	
Sugar and Other Sugar Products	6.423	0.027	0.14
	(31)	(33)	
Mix and Olive Oils	13.138	0.063	0.27
	(43)	(54)	
Canned foods	14.164	0.037	0.32
	(88)	(60)	
Other Foods	13.879	0.161	0.36
	(22)	(68)	

The non-food PL (z_{nf}) is estimated using the Ravallion method (1994). It consists of observing households' behavior whose income is just equal to the food PL ($Y^h = z_f$) where $z_f = \Sigma\, z_i$. These households are in a position to afford basic foodstuffs but prefer to devote part of their income to buy non-food goods. This income part may be considered as the lower non-food PL z_{nf}^l :

$$z_{nf}^l = Y - Y_f = z_f - Y_f \qquad (31)$$

To estimate the non-food component of PL, the QAIDS model is used representing the food share (w_f) as a quadratic function of the total spending value per equivalent adult (Y^h) relative to the food PL (z_f):

$$w_f^h = \omega_f + \beta \ln\left(\frac{Y^h}{z_f}\right) + \delta\left[\ln\left(\frac{Y^h}{z_f}\right)\right]^2 + u_f^h \qquad (32)$$

The OLS estimation of model (Equation 32) gives the following results:

Table 8 Results estimation of the food share

ω_f	β	δ	R^2
0.5948	-0.0626	-0.02	0.328
(168)	(-12)	(-11)	

The coefficient ω_f is an estimated average food share of households having an income level equal to the food PL (z_f). The lower non-food PL (z_{nf}^l) is then given by the following equation:

$$z_{na}^l = (1-\omega_f)z_f \qquad (33)$$

Equation 33 allows to have a relation between the food PL (z_f) and the lower PL (z^l) where z^l = 253.2 dinars per equivalent adult.

$$z^l = z_a + z_{nf}^l = (2-\omega_f)z_f \qquad (34)$$

An upper PL (z^u) maybe deduced which is the minimum income level required at which a household will be able to devote a budget equal to the food PL (z_f) for food items. The upper PL that can be obtained only numerically, allows the estimation of an upper non-food PL corresponding to the maximum reasonable expenditure for basic non-food items.[35]

Conclusion

The purpose of this paper is to propose a methodology, inspired from the consumer theory, which would allow the assessment of the impact of price system reforms on the poor's welfare. These reforms may come as a result of the price system liberalization, fiscal reforms or a suppression of food subsidies.

The analysis of the price system reforms' impact on the poor population addresses an identification and a measure problem. To overcome these problems, an assessment of the effects of price system reforms on poverty using a wide range of PLs and measures was done. The estimation of PL was based on a utilitarian approach. On the measure problem, the class of FGT poverty measures was used, given that they meet minimum requirements of monotonicity, transfer, transfers - sensitivity and decomposability. In addition, poverty measures of King's (1983) equivalent income which is a monetary evaluation of the consumers welfare was used. Thus, the retained poverty measures reflect henceforth the social welfare loss resulting from the presence of some people living with an income level per equivalent adult under the PL.

The estimation of a demand system which would be, as much as possible, in harmony with the consumer theory has therefore been an essential stage in being able to deduce an equivalent income function. Also, the QAIDS demand system of Banks *et al.* (1993) was chosen because, compared to the AIDS demand system of Deaton and Muellbauer (1980a), it allows for a good to be a luxury to some income levels and a first necessity to other levels. The estimation results of the QAIDS model carried out on the Tunisian survey, are globally acceptable and in line with the economic intuition.

The estimation results have been used to simulate the welfare impact of price system reforms on the poor population. Dominance tests have then been used to evaluate the reforms' effects on a wide range of PLs and measures, encompassing different views on both the selection of the poverty measure, and the choice of the PL. Thus, some ideas from the recent literature on welfare modeling on the one hand, and the choice of the PLs and measures on the other, were considered.

This approach has been applied to simulate the impact of a hypothetical reform affecting subsidized food prices in Tunisia. The focus on subsidies problem is largely explained by their importance on the state's budget and also, by the limited available data that limit the study the households' reaction following prices' variation of non-food goods. The main result of this simulation is that this reform would entail an important deterioration of the poor households' welfare. This reform therefore, has to

be accompanied by necessary compensation measures to avoid grave deterioration of the poor population's welfare than the one prevailing currently. It has been verified that the revenue saved by the state as a result of this reform, would it make it possible to eliminate all poverty and even save from 36.8 to 76.4% of the budget devoted to food subsidies, i.e., if a perfect targeting procedure likely to identify the needy groups at no cost, is applied. Targeting using criteria such as the residence area and the education level of the household head appear to be the most adequate that the state could think of to target its social transfers. However, it should be pointed out that this targeting method is characterized by two error types, the costs of which need to be assessed before suggesting an alleviation poverty program based on regional or demographic indicators of the poor population.[36] The first error type is due to the presence of a non-poor group, sharing the same indicator adopted for targeting. This group will take advantage therefore of this program while ideally, it should not be doing so. The second error type is explained by the presence of poor households which do not show the socio-economic or regional features adopted by the targeting procedure. This group will be deprived from benefiting from the alleviation poverty program measures whereas ideally it should be. The assessment of the costs engendered by such errors made up the extended investigations of this study.

Notes

Table 2 Own-price and cross-price elasticities in the urban area

	E_{i1}	E_{i2}	E_{i3}	E_{i4}	E_{i5}	E_{I6}	E_{i7}	E_{i8}	E_{i9}	E_{i10}	E_{i11}	E_{i12}	E_{i1}
Hard Wheat	-2.252	1.553				1.295		0.311	-0.095				
	(-5.9)	(8.2)				(5.2)		(2.5)	(-1.8)				
Tender	1.377	-1.768						-0.193					
Wheat	(8.2)	(-6.6)						(-2.5)					
Other			-0.528	0.442			0.322			0.082	0.194	-0.429	
Wheat			(-3.8)	(2.9)			(2.7)			(3.5)	(4.1)	(-3.5)	
Vegetables			0.069	-0.733		0.221			0.067				
			(2.9)	(-7.5)		(2.5)			(4)				
Fruit					-1.556			0.240	-0.036				
					(-17)			(4.1)	(-2.2)				
Meat	0.439			0.187		-0.618	0.204	-0.128	-0.038		0.043		0.2
	(5.3)			(2.5)		(-4.7)	(3.6)	(-2.6)	(-2.2)		(1.8)		(6.8
Poultry			0.125			0.600	-0.516				-0.172		-0.2
Eggs			(2.8)			(3.6)	(-3)				(-2.9)		(-4.
Milk	0.211	-0.147			0.156	-0.255		-1.400	-0.029	0.025		0.200	
	(2.5)	(-2.5)			(4.1)	(-2.6)		(-9.2)	(-1.8)	(2.3)		(3.3)	
Sugar	-0.234			0.416	-0.087	-0.280		-0.106	-0.011				0.0
	(-1.8)			(4)	(-2.2)	(-2.2)		(-1.8)	(-2.6)				(2.3
Other			0.338					0.396		-1.000			
Sugar			(3.5)					(2.3)		(-1.9)			
Products													
Mix Oils			0.183			0.310	-0.416				-0.627	0.415	-0.1
			(4.1)			(1.8)	(-2.9)				(-3)	(3.6)	(-2.
Olive Oils			-0.263					0.463			0.270	-1.920	
			(-3.5)					(3.2)			(3.6)	(-8)	
Fish						1.306	-0.457		0.074		-0.106		-0.3
						(6.8)	(-4.1)		(2.3)		(-2.4)		(-2.
Canned				0.292		0.305		-0.100		0.068			
Foods				(3.3)		(2.8)		(-2)		(2.7)			
Other Foods	-0.245	0.171			-0.084							0.156	0.0
	(-3.8)	(4.1)			(-2.8)							(3.4)	(2.4

Values between parentheses indicate the t-ratio. For clarities' sake, elasticities prices that are significant to the traditiona
presented.

Table 3 Own-price and cross-price elasticities in the rural area

	E_{i1}	E_{i2}	E_{i3}	E_{i4}	E_{i5}	E_{i6}	E_{i7}	E_{i8}	E_{i9}	E_{i10}	E_{i11}	E_{i12}	E_{i1}
Hard Wheat	-1.863	0.467				0.389		0.093	-0.028				
	(-6.2)	(8.2)				(5.2)		(2.5)	(-1.8)				
Tender	2.104	-2.173						-0.295					
Wheat	(8.2)	(-5.3)						(-2.5)					
Other			-1.077	0.306			0.223			0.057	0.135	-0.297	
Wheat			(-5.2)	(2.9)			(2.7)			(3.5)	(4.1)	(-3.5)	
Vegetables			0.056	-0.783		0.180			0.055				
			(2.9)	(-9.9)		(2.5)			(4)				
Fruit					-2.028			0.245	-0.037				
					(-8.7)			(4.1)	(-2.2)				
Meat	0.406			0.173		-0.647	0.189	-0.118	-0.035		0.040		0.1
	(5.3)			(2.5)		(-5.3)	(3.6)	(-2.6)	(-2.2)		(1.8)		(6.8
Poultry			0.118			0.566	-0.543				-0.162		-0.2
Eggs			(2.8)			(3.6)	(-3.3)				(-2.9)		(-4.
Milk	0.274	-0.191			0.203	-0.332		-1.902	-0.038	0.033		0.259	
	(2.5)	(-2.5)			(4.1)	(-2.6)		(-4.5)	(-1.8)	(2.3)		(3.3)	
Sugar	-0.136			0.241	-0.050	-0.162		-0.061	-0.425				0.0
	(-1.8)			(4)	(-2.2)	(-2.2)		(-1.8)	(-2.6)				(2.3
Other Sugar			0.385					0.451		-1.000			
Products			(3.5)					(2.3)		(-1.9)			
Mix Oils			0.102			0.173	-0.232				-0.792	0.231	-0.0
			(4.1)			(1.8)	(-2.9)				(-6.9)	(3.6)	(-2.
Olive Oils			-0.201					0.354			0.206	-1.703	
			(-3.5)					(3.2)			(3.6)	(-9.4)	
Fish						3.283	-1.149		0.187		-0.268		-0.9
						(6.8)	(-4.1)		(2.3)		(-2.4)		(-8.
Canned				0.210		0.218		-0.072		0.049			
Foods				(3.3)		(2.8)		(-2)		(2.7)			
Other Foods	-0.254	0.177			-0.087							0.161	0.0
	(-3.8)	(4.1)			(-2.8)							(3.4)	(2.4

1 This study is part of the author's thesis entitled Public Spending and the Targeting Problem of Poor Population. The author wishes to thank Professor Jean-Yves Duclos of Laval University, Professor Mohamed Goaied of Faculte des Sciences Economiques et de Gestion de Tunis, and his colleague Bechir Bouaicha for their valuable comments.

2 It is the linear system of expenditure known under the abbreviation LES.

3 Bibi(1998) estimates equivalence scales using the Engle method followed by Deaton and Muellbauer (1986).

4 Note here that Kanbur et al. (1995) have defended on the basis of a non-utilitarian approach, the idea of basing PL on a basket of reference consumption. The deprivation would be in this case proportional to the distance between the current basket consumption of each poor and the basket of reference consumption. Ravallion and Van de Walle (1991) find it difficult to base PL on a basket of reference consumption. They argue that even poor people make choice of consumption and it is necessary to be prudent before advancing judgement on what poor people have to consume.

5 See appendix of Deaton and Muellbauer (1980a).

6 Deaton and Muellbauer (1980a) consider that since $\omega 0$ can be interpreted as the outlay required for a minimal living standard (the PL) when all prices are equal to 1, choosing a plausible value is not difficult. Banks et al. (1993) propose that this parameter lies between

an appropriate interval. The Ravallion method (1994) is used to estimate this interval. The description of this method figures in the Appendix.

7 The two first axioms have been developed by Sen (1976), the third by Kakwani (1980) and the fourth by Foster et al. (1984).

8 See the Axiom N of Sen (1976).

9 The characteristic of any subgroup of poor population may be of regional nature (rural or urban zone, northern region or the south...) or socio-demographic (number of child by household, the occupation nature of the household head, his/her level of education...). Note that decomposability characteristic of the FGT poverty measure is not always respected in all poverty measures suggested in the literature dealing with this subject. As an example, this characteristic is not respected by Sen (1976) or Kakwani (1980) measures. See Foster et al. (1984).

10 This approach is equally followed by Ravallion and Van de Walle (1991).

11 The substitution of the equivalent income to the income in the class of poverty measures FGT was also done by Besley and Kanbur (1988) to study the impact of infra-marginal subsidies' reforms.

12 The subsidies reform analysis belongs to the same area of the optimal taxation theory given that subsidies are simply negative indirect taxes.

13 It is useful to point out that several clusters were not investigated during the same period.

14 To bypass the non-linearity version of the QAIDS model, it is supposed in the first iteration that b(p)=1. Also, it is supposed that z(p)=z where z is estimated following Ravallion's method (1994). Since this approach gives a range of PL, the robustness of coefficients estimated relative to the choice of z is tested. It is noted that, apart from the constants of the model, all coefficients statistically significant are insensitive to the the PL choice.

15 The specific effect to the cluster not measurable in the consumption model, may be justified by the regional differences in the consumption custom.

16 To respect the constant prices hypothesis within the cluster, the average unit value of the cluster for each good i is taken.

17 This step has not been adopted in this application since the quality effect that unit values can contain, is neglected. This may not change results of elasticity estimation prices since a recent application, developing the procedure of Deaton (1988) on these same data, has shown the quasi - absence of the quality effect. For this subject, see the study of Ayadi et al. (1995a).

18 This affirmation is more legitimate when the number of households in the cluster is high. ($Hc \rightarrow \infty$).

19 It is easy to verify that .

20 It is clear that the constants variables contribution within cluster, the prices effects, are not identifiable in this first step.

21 $[\ln(y^{c\cdot})]^2 = \frac{1}{H_c}\sum_h [\ln(y^{hc})]^2$ the other averages are calculated using the same way.

22 If these two essential components are neglected, elasticity estimations obtained may be biased. Instrument vector is chosen for unit values: t = {ln(Y), demographic, regional and temporal indicators variables}.

23 This statistics is distributed according to a Chi - square to k freedom degrees, with k as the number of instrument variables. In the absence of quality effect and measurement errors, this statistics is close to zero.

24 If Hausman's (1978) specification tests are significant for most goods, it is useful to use the triple least square under restrictions of homogeneity and the symmetry. In fact, the application of OLS under these restrictions, is sufficient because the test is not significant for most of the goods items considered in this study.

25 This empirical step is more justified in the second step when the estimation of price effects is carried out on averages of clusters. Elsewhere, empirical results confirm it since the estimation of Equation 21 on the totality of clusters has improved the accuracy of elasticities in comparison to an estimation separated in the urban and rural zone. In addition, the estimation of price effects on the totality of clusters justifies more the thesis of the spatial price variation.

26 This is fundamental to improve food subsidies targeting for poverty alleviation in Tunisia. Indeed, 75% of the 20% of the poorest households live in the rural areas.

27 During the first step, it was not useful to apply the same procedure for parameters of income variables given that income elasticities of the QAIDS system depend on the income level of households.

28 These anomalies appear in the estimation results of Ayadi et al. (1995a) who used the same survey.

29 According to Equation 11, Yz corresponds to the PL in the post-reform situation evaluated under the price system Pp.

30 See Besley and Kanbur (1993).

31 See Besley and Kanbur (1988).

32 The linear demand system allows to estimate a poverty line by reference to a fixed consumption bundle that is too restrictive. To reduce disadvantages of the LES choice, the poverty line has been decomposed in two components and to use this system only for the estimation of food PL.

33 Ayadi and Matoussi (1995) have followed the nutritional approach to estimate this component. Also, they do not consider equivalence scales when estimatig their range of poverty lines.

34 Note that the estimation of the model (30) requires to use a non-linear estimation algorithm. To avoid the complexity of non-linear estimation, an iterative method is suggested to estimate this model.

35 The equation allowing to assess the upper poverty line is :

$$z_f = w_f z^u = \omega_f z^u + \beta \ln\left(\frac{z^u}{z_f}\right)(z^u) + \delta\left[\ln\left(\frac{z^u}{z_f}\right)\right]^2 (z^u)$$

what gives an upper poverty line equal to 327.5 dinars per equivalent adult. Note finally that these results are close to those found by Ayadi et al. (1995b).

36 See for example Baker and Grosh (1994) and Cornia and Stewart (1995).

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