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Sami Bibi

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ECONOMIC RESEARCH FORUM
منتدى البحوث الاقتصادية
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7 Boulos Hanna St. Dokki, Cairo, Egypt
Tel: (202) 3370810 – (202) 7485553 – (202) 7602882
Fax: (202) 7616042. Email: erf@idsc.net.eg. Website: http://www.erf.org.eg

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Abstract

This paper starts by presenting a descriptive analysis of the effects of general food subsidies on poverty in Tunisia; as revealed by the household survey data for 1990. The analysis indicates that the poorest certainly take advantage of this system, but at the price of considerable leakages to the non-poor and a sizeable economic efficiency loss resulting from the relative price distortions. Further, non-parametric estimations suggest that there are no commodities predominantly consumed by the poor. This implies that a subsidy program is not an effective way to fight against poverty and so, it is unlikely to improve significantly the living standard of the less well-off members of society by restructuring the current program. We investigate then the impact on poverty of a more targeted transfer scheme, based on proxy means tests, using an appropriate econometric technique to model it. Simulations show that this design would be more effective in reducing poverty than general food subsidies. Dominance tests are also used to assess the likely effects of this reform on a wide range of poverty lines and poverty measures. The main result is that this design would first-order-dominate a food subsidies scheme within a range of poverty lines including all those estimated for Tunisia.

1. Introduction

Alleviating poverty is a major objective of economic development. Economic growth was generally considered a necessary condition for decreasing poverty [Bhagwati (1985)]. Yet it has been increasingly recognized that growth alone may not be sufficient to significantly improve the well-being of the low-income households [Stewart (1985)]. Hence, programs specifically designed to decrease poverty should be addressed in developing countries. Among available tools to enhance the lot of the poor, subsidizing food staples mainly consumed by the poorest, has been very popular in such countries. The problem is that food subsidies do not fulfill the two goals of any public spending item, that is to promote efficiency, by reducing the economic distortions, and increasing equity, by substantially improving the income distribution[1]. In addition to these failures, the leakage share from food subsidies program, henceforth FSP, to non-poor people is generally considerable. Hence, with structural adjustment programs, large cuts in public spending are required, leading many developing countries to move from universal transfers to more targeted schemes.

The objective of this paper is then twofold. First, we aim to analyze the effects of one of the most important tools for alleviating poverty in Tunisia, that is the universal FSP. Second, we study the possibility of using a direct transfer scheme as an alternative tool to alleviate more poverty; revenue-neutrally[2]. Indeed, with the advent of tight budgetary constraints through the adoption of the structural adjustment program in 1986 and the free trade agreement (FTA) with the EU in 1995, improving the welfare of the poorest group without increasing social public spending becomes one of the most sought after objectives.

Considered in the beginning of the 70s as a suitable means to improve the welfare and nutritional intake of the poor, universal FSP no longer make the unanimity, especially with the decline of the incidence of poverty, according to official statistics, from 40 percent in 1967 to 7.6 percent in 1995[3]. In reality, with 40 percent of population living with an income level under the poverty line, FSP is an efficient tool to reduce inequality and lessen poverty. Yet, if the incidence of poverty corresponds to 7.6 percent, this tool becomes inefficient, since the leakage from FSP to the well-off members of society would be certainly considerable while failure to substantially serve all those in the target group would be manifest.

Furthermore, with the stagnation of poverty during the period 1990 - 1995, in spite of a sustained growth of the real income *per capita* and a social expenditure maintained at a stable level as a percentage of the GDP, new policies to combat poverty have to be found to downward this trend, especially because the future economic mutations following the FTA with the EU could increase the incidence and the depth of poverty. Because these policies cannot be financed by increasing social expenditures, to prevent an upward movement of fiscal deficit, it is worthy to study the extent to which more targeted transfers, using exactly the same food subsidies funds, will allow to go much further in reducing poverty.

Searching for a poverty-alleviating reform requires ranking the population according to its economic well-being. A definition of a well-being indicator has to be agreed upon to allow the determination of who is poor and who is non-poor. The definition of such an indicator could be expanded. For instance, Mayshar and Yitzhaki (1996) allow well-being to be affected by two variables, namely ability and needs. Given ability, the greater the needs of a household are, the lower its welfare level is; and, given needs, the greater the ability, the greater is the well-being of a household. This kind of extension is appealing for the treatment of household size, in which there are economies of scale in the intra-household consumption. Yet the technical requirements of such an extension are beyond the scope of this paper. Thus, the empirical applications reported below are based on total expenditure per capita that is assumed as an adequate indicator of each household's welfare as well as a good proxy for (permanent) income [Jorgenson (1998) and Slesnick (1998)].

The first part of this work is then devoted to the analysis of general food subsidies effects on poverty. This analysis requires that we have econometric estimates of the relevant demand system[4]. Given this information, we can compute first the equivalent income gain, as defined by King (1983), for each household in the sample resulting from the current FSP. This yields an appropriate estimate of deadweight loss, and may be used to assess the impact on poverty of this scheme; using different poverty measures and a wide range of poverty lines. In addition, it will be instructive to test if it is possible to reform this system so as to increase the poorest share of food subsidies benefits. For this purpose, we need an estimate of the expected expenditure on each commodity conditional upon individuals' income, which can be obtained consistently by non-parametric regressions. If estimation results reveal the presence of some commodities that are largely consumed by the poorest, increasing food subsidies to these commodities should be an effective way to further reduce poverty. Otherwise, designing an alternative means to achieve this goal becomes appealing.

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[1] Ahmad and Stern (1991) present a general framework in which the trade-off between economic efficiency and equity is addressed. The equity concern is related to the minimization of poverty in an alternative framework suggested by Bibi (1998).

[2] With revenue-neutral reforms, the problem of the optimal size of the government activity is ignored. Considering an alternative assumption requires that the households' willing to pay for public goods is available in the survey. See King (1983).

[3] For an exhaustive analysis of the poverty trend in Tunisia, see The World Bank (1995, 1999).

[4] The methodology followed to choose and estimate the relevant demand system as well as the estimation results are available in Bibi (1998).

Unfortunately, non-parametric estimations suggest that there are no commodities principally consumed by low-income households. Therefore, the second part of this work illustrates how proxy means tests, using an appropriate econometric technique to model it, could be used to reach a better outcome on poverty. Household characteristics are used as explanatory variables to compute the income transfer to be awarded to each household; as deduced from a model designed to minimize the severity of poverty given an anti-poverty budget.

The approach developed in this paper has been applied using a data set from Tunisia. Expending the same anti-poverty budget currently devoted to FSP, simulations reveal large potentialities in alleviating poverty, if targeting by commodities is replaced by the transfers scheme resulting from our methodology to proxy means tests. For instance, using robustness analysis to avoid critical choices of poverty lines and/or poverty measures, the results show that the simulated design would first-order-dominate universal FSP within a wide range of poverty lines, which includes all those estimated for Tunisia.

This paper is structured as follows. Section 2 provides a broad characterization of the food subsidies effects on poverty, as well as an evaluation of the leakages and deadweight loss resulting from this scheme. Section 3 illustrates how targeting by indicators, when it is derived from an adequate framework, can be used to achieve a better outcome on poverty. Also, dominance conditions are tested to assess the likely effects of the simulated design on a wide range of poverty lines and poverty measures. Section 4 offers some concluding observations.

2. Food Subsidies Effects on The Poor Population Welfare

We assume that before implementing the FSP, each household h has an exogenous income y^h and faces the price system $\mathbf{p}^o$. After implementing the FSP, by expanding the compensation fund B available to finance this policy, each household has the same nominal income, y^h, but faces a new price system $\mathbf{p}^p$. We aim to compare the levels of a household's welfare when it faces different price systems. To achieve this goal, we choose a benchmark price system, denoted by $\mathbf{p}^r$, and we define as King (1983) the concept of equivalent income: for a given budget constraint $(\mathbf{p}, y)$, equivalent income is defined as that income level which allows, at the benchmark price system, the same utility level as can be reached under the given budget constraint. Formally, we have:

$$v(\mathbf{p}^r, y_e) = v(\mathbf{p}, y) \tag{1}$$

where $v(.)$ is the indirect utility function, $\mathbf{p}$ is a vector of price system, and y is a vector of a household's income per capita. Notice that since $\mathbf{p}^r$ is fixed across all households, y_e is an exact monetary metric of actual utility $v(\mathbf{p}, y)$ because y_e is an increasing monotonic transformation of $v(.)$. Thus, inverting the indirect utility function, we obtain the equivalent income in terms of the expenditure function:

$$\begin{aligned} y_e &= e\left(\mathbf{p}^r; v(\mathbf{p}, y)\right) \\ &= y_e(\mathbf{p}^r, \mathbf{p}, y) \end{aligned} \tag{2}$$

where $e(.)$ is the expenditure function, that is the minimal amount of income necessary to reach utility v at prices $\mathbf{p}$, and $y_e(.)$ is the equivalent income function[5]. The properties of the equivalent income function are derived from those of indirect utility and expenditure functions. So, $y_e(.)$ is increasing in $\mathbf{p}^r$ and y, decreasing in $\mathbf{p}$, homogeneous of degree 1 in $\mathbf{p}^r$, and homogeneous of degree 0 in $(\mathbf{p}, y)$.

If $\mathbf{p}^r$ is set to be equal to the non food subsidies price system, that is $\mathbf{p}^r = \mathbf{p}^o$, the move from the original situation to the current one, characterized by the subsidy of some food items, could then be considered as a first means to fight against poverty by enhancing particularly the purchasing power of lower-income groups. The maximum gain per capita for each household, M^h, resulting from the implementation of food subsidies scheme could be computed using the next formula:

$$M^h = (\mathbf{p}^p - \mathbf{p}^o) x^h, \tag{3}$$

where x^h is the consumption basket per capita of household h purchased following this policy. Because it does not require any hypothesis on the consumption behavior of households, M^h is easily to compute. Considering the excess burden or deadweight loss (henceforth DL) resulting from distortionary subsidies, this measure overestimates, however, the welfare improvement of households. A satisfactory measure of the households' value of this program is the change in their equivalent income. This measure of welfare gain is known as the equivalent gain per capita, E^h, and it is given by:

$$\begin{aligned} E^h &= y_e(\mathbf{p}^o, \mathbf{p}^p, y^h) - y_e(\mathbf{p}^o, \mathbf{p}^o, y^h) \\ &= y_e^h - y^h. \end{aligned} \tag{4}$$

Implementing FSP is equivalent to awarding each household a transfer equal to the value of its equivalent gain. Notice that the DL resulting from distortionary subsidies let the equivalent gain always be less important than the maximum gain. Hence, a natural definition of the excess burden arising from this distortionary transfer is:

[5] It is obvious that $y_e(\mathbf{p}^r, \mathbf{p}^r, y) = y$.

$$DL = \overline{M} - \overline{E}, \quad (5)$$

where $\overline{M}$ and $\overline{E}$ are respectively the average of the maximum and equivalent gain.

In addition to information about the distribution of welfare gains among households, it is worthy to assess the social impact of the scheme under consideration. Owing to the fact that the main objective of FSP is to redistribute income toward the least well-off groups, a natural measure of the social impact of this policy ought to be given by the decline of a pre-specified poverty measure. The poverty measures that meet our analysis requirements should satisfy axioms of focus, monotonicity, transfer, transfer-sensibility, and decomposability[6]. Many poverty measures can be expressed in terms of poverty gaps g for income y and poverty line z as:

$$g^h = \max\{z - y^h, 0\}.$$

Following Jenkins and Lambert (1997), poverty measures which are defined in terms of g and which are in line with the aforementioned axioms belong to the class of Generalized Poverty Gap (GPG) indices. An important subset of GPG is the FGT set of additively decomposable indices suggested by Foster et al. (1984), which can be written as[7]:

$$P_\alpha(z,y) = \frac{1}{H}\sum_{h=1}^{H}\frac{n^h}{\overline{n}}(g^h)^\alpha \quad (6)$$

where H is the total number of households in the survey, n^h is the size of household h, $\overline{n}$ is the average size of households, and α may be considered as a measure of poverty aversion: a larger α gives greater emphasis to the poorest of the poor. When α becomes very large, $P_\alpha(.)$ approaches a Rawlsian measure, which considers only the poorest households' welfare. The FGT class given by expression (6) involves many commonly used poverty measures as special cases. For instance, when $\alpha = 0$, $P_0(.)$ is the incidence of poverty (or the headcount ratio) which fails to satisfy the monotonicity and transfer axioms; while for $\alpha = 1$, $P_1(.)$ is the (non-normalized) poverty deficit which is only a good measure if all the poor have the same living standards[8]. The transfer axiom is then fulfilled for $\alpha > 1$, and the transfer sensitivity axiom requires $\alpha > 2$.

Considering we wish to assess the effects of FSP on the poor population, poverty measures should be sensitive to price system variations. For this purpose, we present them in terms of values of the equivalent income function[9]. Hence, the social impact of the current anti-poverty program can be evaluated by computing the decline of a given poverty measure according to the next formula:

$$\Delta P_\alpha = \frac{1}{H}\sum_{h=1}^{H}\frac{n^h}{\overline{n}}\left(z_e - y_e(\mathbf{p}^o, \mathbf{p}^o, y^h)\right)_+^\alpha - \frac{1}{H}\sum_{h=1}^{H}\frac{n^h}{\overline{n}}\left(z_e - y_e(\mathbf{p}^o, \mathbf{p}^p, y^h)\right)_+^\alpha. \quad (7)$$

where z_e is the equivalent poverty line, that is the minimum expenditure level required at $\mathbf{p}^o$ to reach the indifference curve corresponding to the minimum standard of living one[10].

Furthermore, since the poverty measures are estimated on the basis of sample observations, we need to test whether the predicted magnitude and direction of change in poverty following this anti-poverty scheme is statistically significant, which is possible using the test of Kakwani (1993):

$$\kappa = \frac{\Delta P_\alpha}{\sigma(\Delta P_\alpha)} \quad (8)$$

where $\sigma(.)$ is the standard error of ΔP_α[11]:

$$\sigma(\Delta P_\alpha) = \sqrt{\frac{P_{2\alpha}(z_e, y) - [P_\alpha(z_e, y)]^2}{\overline{n}H} + \frac{P_{2\alpha}(z_e, y+E) - [P_\alpha(z, y+E)]^2}{\overline{n}H}}.$$

The methodology presented above is applied to a data set from the 1990 Tunisian survey. This is a multipurpose household survey which provides information on expenditures and quantities for food items and expenditures for non-food items, as well as on many other dimensions of the behavior of 7734 households; including the consumption of own production, education, housing, region of residence, demographic information, and economic activities. The application of

[6] The three first axioms are suggested by Sen (1976), the fourth by Kakwani (1980), and the fifth by Foster et al. (1984).

[7] In reality, this is a non-normalized version of the FGT poverty measures class, adopted also by Chakravarty and Mukherjee (1998). The normalized version is defined in terms of relatives poverty gaps φ, where:
$\varphi^h = \max\{1 - y^h/z, 0\}$.

[8] See the Axiom N of Sen (1976).

[9] The substitution of the equivalent income to the income in the FGT class of poverty measures was equally done by Besley and Kanbur (1988) to study the impact of infra-marginal subsidies' reforms and Ravallion and van de Walle (1991) to study the impact on poverty of food pricing reforms.

[10] The utility level v is here normalized so as to lie between 0 (minimum standard of living) and 1 (bliss). So $e(\mathbf{p}^o, 0)$ is the cost of the minimum standard of living or, saying differently, the equivalent poverty line.

[11] It is evident from equation (4) that $y_e(\mathbf{p}^o, \mathbf{p}^p, y^h) = y^h + E^h$.

this methodology requires to compute foremost the equivalent income function, $y_e(.)$, the construction of which calls for the estimation of an appropriate demand system. The analysis of the relationships between budget shares of different foodstuffs and household's logarithm income, using non-parametric regressions[12], has led Bibi (1998) to estimate the *IQAIDS* demand system of Banks et al. (1993), since it best characterizes the preferences of households[13].

We study the impact of FSP through a wide range of poverty lines. As the specification problem of the poverty cut-off is beyond the scope of this study, we just use poverty lines estimated by Bibi (1999) following a utilitarian approach. Because these estimations are made under the food subsidies price system, $\mathbf{p}^p$, we have to adjust them in order to compute for each estimated value the corresponding equivalent poverty line, z_e. Table 1 reports the estimation results of poverty lines of Bibi (1999) as well as the corresponding equivalent poverty lines computed with the help of Bibi's (1998) estimation results of the *IQAIDS* demand system and using equation (2).

Arguably, a general equilibrium model is required to elicit the sharing out of food subsidy benefits between firms and households. Most computable general equilibrium models broadly assume that all production functions are homogeneous of degree one and that there is perfect competition. Under these assumptions, the supply curve of each commodity is horizontal so that consumers reaped the entire benefits of the indirect transfers. For simplicity, we assume such framework, although there is nothing in the following approach which prevents the introduction of alternative hypotheses. Therefore, through this scheme, consumer price is lowered below marginal cost by 37 percent for hard wheat, 35 percent for tender wheat, 9 percent for other wheat, 14 percent for poultry and eggs, 18 percent for milk, 24 percent for sugar, and 34 percent for grain oil. The outcomes of this program, for different values of equivalent poverty line and aversion to poverty, are summarized in table 2.

The presence of FSP is a meaningful source of welfare improvement for the poor, as the statistically significant decline of all poverty measures proved. In addition, table 2 shows that the subsidies on foodstuffs benefited more the poorest of the poor than the richest in relative terms, that is, the food subsidies program is progressive in relative terms. For instance, we note that poverty reduction is less important than the equivalent poverty line rise for a given value of poverty aversion. This result would be strengthened if it could be shown that the contribution of equivalent gain to total expenditure, (E^h/y^h), declined monotonically with increases in income. In figure 1, we display the results of the link between these two variables obtained using a non-parametric estimation, with Gaussian kernel and bandwidth selected to minimize the mean integrated square error. The results are revealing, since they confirm the progressive feature of the food subsidies program. Also, as the slope of figure 2 is never positive, regardless of the (equivalent) poverty line chosen, we can argue that the post-subsidy distribution of expenditures dominate the (hypothetical) pre-subsidy one within all the range variation of income[14].

Performances of the universal FSP, in reducing both the deficit of poverty and inequality, do not indicate, however, that it is an optimal transfer design. Indeed, the magnitude of the income transfer to the non-poor, that is the leakage of the program benefits, is very important. The distribution of the absolute benefits between the different quintile groups, arranged in ascending order from the poorest quintile to the richest, is reported in table 3.

Table 3 shows that the anti-poverty program at hand benefited the rich more than the poor in absolute terms. The richest quintile group of the population received 2.2 times more of the equivalent gains from FSP than the poorest, with an average equivalent gain per capita $(\overline{E}_s)$ of 41.25 DT and 18.75 DT respectively[15]. This mistaken awarding of transfers to the non-targeted group reduces the vertical efficiency of this scheme and leads to the leakage of program benefits. It is obtained by adding the transfers that are given to those who are ineligible under perfect targeting and the total cost of the DL. Indeed, the excess burden cost represents another source of leakage, which is specific to the distortionary transfers, and should be so added to the traditional leakage cost. The leakage ratio, which is obtained by dividing the leakages by the available budget, approximates at least 75 percent of the anti-poverty funds even if we should admit that 40 percent of the population are poor[16]. Further, 16.7 points of percentage of the leakage ratio are related to the excess burden cost. In the absence of this distortionary cost, the equivalent gains would equalize the

[12] For more details regarding non parametric estimations, see Silverman (1986).

[13] Different parameters of *IQAIDS* demand system are estimated according, to some extent, to Deaton's (1988) methodology, who assumes spatial price variation in the survey and makes use of unit values as indicators of market prices. For more of details, see Bibi (1998).

[14] In the stochastic dominance literature, this result is known as "first-order dominance."

[15] In 1990, 1 DT corresponds almost to 1 US dollar.

[16] Creedy (1996) has distinguished between the vertical expenditure inefficiency, that is equal to the leakage ratio as defined here, and the poverty reduction efficiency which includes also the total transfers which, although received by the pre-transfer poor, are in a sense unnecessary since these individuals are raised above the poverty line. Because the cost of unnecessary transfers is really insignificant when anti-poverty design is based on targeting by commodities, we ignore its computation in this section.

maximum gain. Instead, the poverty relief resulting from FSP, for different values of poverty line and aversion to poverty, would be as reported in table 4[17].

Table 4 reveals that the opportunity cost of the excess burden in terms of poverty reduction is between 2 and 3 percent according to the poverty line and poverty measure selected. Regarding the weight of the DL and, especially, the weak benefits targeted to the poorest group, the restructuring of this scheme should be a pressing priority. Thus, it is worthy to investigate first, reform possibilities within the existing framework of FSP over those requiring a new institutional structure to avoid the transition costs of such a move[18].

The previous analysis raises the question of how to improve targeting by commodities so as to transform program incidence from a situation in which the FSP awards more absolute benefits to the non-poor than the poor, to one in which the absolute benefits decline monotonically with increases in income. For this purpose, we need an estimate of the expected expenditure on each commodity conditional upon individuals' income, which could be obtained consistently by non-parametric regressions[19]. If the estimation results reveal the presence of some commodities predominantly consumed by the poorest, increasing food subsidies to these commodities should be an effective way to raise the poorest share of food subsidies benefits; and so to lessen more poverty. Estimation results of the income-expenditure relationship for different commodities (the Engel curves) are displayed graphically in figure 2.

It is worthwhile to give another interpretation of this figure. Consider a policymaker who aims to decrease the incidence of poverty but does not know who is really poor. To be on the safe side, it is best to lessen the headcount ratio regardless of the poverty line chosen[20]. This requires the presence of some commodities whose expenditures exhibit downward sloping across different income groups (at least from a threshold level of income) and even fall down at higher income groups. Unfortunately, the main feature of the regressions shown in figure 2 is that there is no commodity fulfilling this requirement. Restructuring the current scheme, by reducing subsidies on other subsidized items and raising them on wheat and cooking oil, could probably decrease to some extent leakages, and thus poverty. Given that the non-poor purchase all commodities, this is not an effective means to increase targeting accuracy and so, it is unlikely to improve significantly the living standard of the poorest without looking for an alternative targeting procedure.

3. An Alternative Means to Fight Against Poverty: Proxy Means Tests

The previous findings reveal chiefly that leakages from FSP to non-poor people are very large while failure to substantially relieve the social conditions of the poorest is manifest. Because governments have limited resources, and given that it is important to use them efficiently, looking for an alternative targeting tool to achieve more poverty reduction is an appealing goal. However, it is not usually easy to identify the poor directly. Whilst such identification is required to curb poverty given an available budget, it is unlikely to be cheaply administratively feasible [Besley and Kanbur (1993)]. It is for this reason that among targeting options, awarding benefits to the poorest based on targeting by indicators could be an attractive alternative to targeting by commodities[21].

There is plenty of theoretical modeling and empirical estimation addressed to the question of how to provide assistance to poor people when it is possible to observe some individuals' characteristics, but not their income. For instance, Ravallion and Chao (1989) have modeled the targeting problem as one of minimizing some particular poverty measures subject to an anti-poverty budget. They have constructed an algorithm allowing an optimal use of a limited number of dummy variables by explicitly minimizing a selected poverty measure given an available budget. The targeting scheme allowed equal transfers to all individuals within a group, but different transfers between groups of different characteristics. The main issue with this method is that it cannot be applied without losing some information, especially when some available variables are continuous.

To avoid this drawback, Glewwe and Kanaan (1989) as well as Baker and Grosh (1995) have followed a two-step procedure leading to a least predicted poverty. In a first step, the expectation of households' income per capita conditional on socio-demographic characteristics was parametrically estimated by ordinary least square (OLS) regression. In the second step, Glewwe and Kanaan (1989) have suggested to assign to each poor person a transfer equal to the difference between its predicted income and the poverty line; but Baker and Grosh (1995) have

[17] A further attraction of this calculation is to avoid the detrimental effects of the biased estimation results of the demand system when comparing the outcome of the current scheme on poverty with alternative design. Indeed, if the evaluation of the excess burden cost, which depends on the estimation results accuracy of the demand system, is found to be exaggerated, the impact of food subsidies on poverty would be thus underestimated. So table 4 reports the maximum poverty alleviation which could be achieved even if the current scheme is non-distortionary.

[18] The costs of transition are related to the political, economic, and administrative constraints of implementing a more targeted program which usually excludes powerful groups of the population. For instance, see Besley and Kanbur (1993).

[19] The main hypothesis justifying this approach use is that the conditional expenditure distribution is a smooth function of income. Further, this approach has less rigid assumptions about the distributions of either the dependent or explanatory variables or of the error term.

[20] This is necessary to have a post-reform income distribution which first-order-dominates the pre-reform income distribution, regardless of the poverty lines and poverty measures chosen.

[21] On the advantages and drawbacks of the main imperfect targeting options, see Baker and Grosh (1995), Bibi (1999, 2000), Bigman and Fofack (2000), Glewwe (1992), and Ravallion (1992).

suggested to insure the same transfer to each individual having a predicted income less than the poverty line[22].

Whilst poverty measures are not sensitive to welfare variations of the non-poor by focus axiom, the predictive power of the OLS method is increased when the errors between true and predicted income at the top of the welfare distribution decrease. So, the OLS technique is not a suitable choice since a higher predictive power does not always lead to a better targeting accuracy. Hence, seeking to overcome the weakness of both OLS regression and Ravallion and Chao's (1989) algorithm, Glewwe (1992) has developed an alternative algorithm allowing the use of a great number of dummy and continuous variables. Although Glewwe's approach is theoretically as plausible as Ravallion and Chao's (1989) one, it is much more difficult to compute, and does not produce results really different from those based on OLS regression [Baker and Grosh (1995)].

The methodology followed here attempts, to some extent, to go over the basic difficulties of previous approaches while preserving their main advantages. Thus, it is theoretically plausible, easier to compute, and enables the use of a large set of discrete and continuous variables.

Assume that $P_\alpha(.)$ is unaffected by the vector of transfers T[23]. Assume equally that each household is a representative one of a given subgroup of the population with $P_{h,\alpha}(.)$ is the $P_\alpha(.)$ measure for the h^{th} subgroup. When the objective is to minimize poverty given the anti-poverty budget B, through a poverty alleviation design, the optimal awarding of benefits is the one leading to the least poverty, as defined by a pre-selected FGT measure. Formally, the optimal allocation of benefits is derived by resolving the program below:

$$\begin{aligned} &\text{Min.}P_\alpha[z_e, y_e(\mathbf{p}^o, \mathbf{p}^o, \mathrm{T})] = \sum_h w^h P_{h,\alpha}[z_e, y_e(\mathbf{p}^o, \mathbf{p}^o, T^h)] \\ &\text{subject to } \sum_{h=1}^{H} n^h T^h = B, \end{aligned} \tag{9}$$

where w^h is the proportion of the population having the same characteristics of household h[24]; and T^h is the per capita transfer to be awarded to subgroup h in perfect targeting so as to go furthest in minimizing poverty. It is required to be non-negative for all subgroups, since we do not have to consider how the available budget B is financed.

From Kanbur (1987), we know that if the population is divided into mutually exclusive subgroups, when the objective is to minimize the α^{th} order measure $P_\alpha(.)$, the budget should be allocated so as to equalize the $(\alpha - 1)^{th}$ order measures $P_{h,\alpha\text{-}1}(.)$ in the different subgroups. In reality, the available budget could not permit to reach all the subgroups. For $\alpha > 1$, some richest subgroups of the poor should be then excluded from the benefits of this program since it is optimal to transfer the entire anti-poverty budget to the poorest subgroups of the poor[25]. The available budget will be spent so as to decrease as many of the poorest subgroups measures $P_{h,\alpha\text{-}1}(.)$ as possible up to a common measure $\overline{P}_{h,\alpha-1}(.)$ down their initial one.

Obviously, $P_{h,\alpha\text{-}1}(.)$ is often costliness to observe directly, so that perfect targeting is not feasible. Yet these poverty measures are likely to be correlated with observable variables, denoted by the vector x. If x contains regional characteristics, it is possible to make use of the regional targeting approach to study to what extent their outcomes could be better than those of targeting by commodities [Bibi (1999)]. But if x includes other variables that are not continuous, targeting accuracy of transfers to the poorest could be certainly enhanced, and Ravallion and Chao's (1989) algorithm becomes the best means to get an optimal allocation of the available budget. As discrete and continuous variables are often found in x, this algorithm cannot be used without losing some information; especially because continuous variables should be beforehand transformed into discrete ones.

A suitable technique is available, however, if the problem could be addressed as a censored model, in which case Tobit regression becomes a relevant tool to avoid many drawbacks of previous approaches:

$$\begin{aligned} &P_{h,\alpha-1}(z, y^h) = \Phi(x^h) + \hat{\vartheta}^i \qquad \text{if} \qquad y^h < z \\ &P_{h,\alpha-1}(z, y^h) = 0 \qquad\qquad\qquad \text{otherwise.} \end{aligned} \tag{10}$$

The estimation of $\Phi(.)$ is then theoretically very plausible. The transfer scheme that would result from the estimation of equation (10) is explicitly estimated with regard to the functional form of the pre-selected poverty measure. Furthermore, for a large value of α, estimation of equation (10) takes into account the fact that the corresponding poverty measures are more sensitive to errors of exclusion

[22] The transfer scheme suggested by Baker and Grosh (1995) is not an optimal one since it is not deduced from the minimization of any predicted poverty measure, unless all poor have the same predicted income.

[23] Besley and Kunbur (1993) provide a discussion about the incentive effects of a transfer scheme targeted to poor population.

[24] Since we have a representative data set, we can consider that $(n^h / \overline{n}H)$ is a non-biased proxy of w^h.

[25] On the other hand, for $\alpha < 1$, they show that it is optimal to spend the available so as to lift as many of the richest subgroups of the poor out of poverty as possible. This corresponds to an 'r-type' transfer scheme.

among poorer households. Finally, the probability that a higher predictive power of Φ(.) leads to a better targeting accuracy is so far more important than that of a higher predictive power of OLS estimation.

The methodology presented above can be implemented for different values of poverty aversion. For instance, if the objective is to minimize $P_2(.)$, the equation (10) must be estimated using as a dependent variable the deficit of poverty, that is g^h.[26] An equivalent poverty line of 360 DT *per capita* per year is used. The explanatory variables used to estimate the model are reported and defined in table A-1 in the annex. These variables could be clustered in two sets. In set I, we find the vector x^I which includes only regional characteristics of the households. Thus, this set enables us to compare performances of model (10) in alleviating poverty with regard to those which could be achieved when the regional targeting model, as developed by Kanbur (1987), is adopted to deduce an optimal allocation of B. Set II (vector x^{II}) includes in addition to regional indicators, demographic information of each household and some characteristics of the household's dwelling. While it is technically easy to add other information, like the nature of the occupation of the households' head and their education level, we avoid doing so since some people attempting to become eligible or to get more transfer may effortlessly conceal these variables. Table A-2 in annex presents Tobit estimators of the equation (10).

Using the estimation results of the equation (10), table 5 gives the effects on the poor population's welfare of the two estimated models (reported in the two last columns) to be compared to the outcomes of targeting by commodities (reported in second column).[27] Besides, this table reports (in the third column) the outcomes of regional targeting model, as simulated in Bibi (1999), when the objective is to minimize $P_2(.)$.

For the purpose of comparing our methodology to other previous one, table 5 shows that the Tobit regression performs as well as the geographic targeting model when we use only regional variables. This evidence supports the fact that our procedure could be at least as useful as the previous ones that are theoretically plausible.[28] Broadly, using only regional characteristics lowers leakages by 14 percentage points. This decline entails a significant reduction of poverty from the original level - given by the food subsidies scheme - when the aim is to minimize the severity of poverty, $P_2(.)$. This decline is between 6 and 15 percent according to whether the poverty measure retained is $P_0(.)$ or $P_2(.)$.

Performances of regional targeting do not indicate, nevertheless, that it is the optimal transfer scheme. Adding demographic and dwelling information on households to provide assistance to the poor, simulation II reveals an additional decline in leakages, which allows for poverty alleviation more than regional targeting does. Poverty could be reduced further by 10 percent for $\alpha = 0$ up to 18 percent for $\alpha = 2$.

The analysis that we have just led is based on the choice of a poverty line z and a poverty measure $P_\alpha(.)$ whose specification can be made arbitrary. The literature on poverty dominance provides methods for addressing particularly these two problems. For instance, Atkinson (1987) has defined criteria of dominance corresponding to levels of stochastic dominance. He has also underlined that lower degree dominance usually entails higher degree dominance, but that the converse does not necessary hold[29].

Suppose that it is possible to agree neither about the choice of the poverty line, that is the poverty line position in the resource space, nor about the choice of the poverty measure. Then, it can be shown that poverty will certainly fall following the simulated design based on indicators included in x^{II}, regardless of the poverty line and the poverty measure chosen, if we have:

$$\Delta P_0(.) = P_0(z_e, y + M) - P_0(z_e, y + T^{II}) \geq 0 \qquad (11)$$

for all z_e with at least one strict inequality. In the dominance literature, this finding is known as "first-order dominance" (FOD). Figure 3 illustrates the relationship of universal FSP and the simulated design to FOD and the headcount ratio variation.

Hence, by plotting the cumulative difference in the percentages of the population below various equivalent poverty lines, we find that $\Delta P_0(.)$ could be negative. The impact of providing assistance to the poor based on targeting by indicators with regard to targeting by commodities is therefore ambiguous. Some equivalent poverty lines and some poverty measures will show a better effect on poverty following the p-type transfers scheme, but some others will show a contrasting outcome. Yet, if it is admitted that the equivalent poverty line could never exceed 540 DT, then it is possible to argue that targeting by indicators of transfers is unambiguously more effective in serving the poorest than universal FSP, no matter which FGT poverty measure is chosen. It is perhaps useful here

[26] The squared poverty deficit, $(g^h)^2$, is the dependent variable when the aim is to minimize $P_3(.)$. Such an extension is let for future research.

[27] The DL costs resulting from food subsidies are ignored in the following comparison. Indeed, if the simulated reforms decrease more poverty under this hypothesis, these results would be at least maintained under an alternative hypothesis.

[28] For instance, when only regional characteristics are included for OLS regression, the outcomes produced by Baker and Groch's (1995) procedure are far from being in compliance with those obtained from geographic targeting model. We have also checked that the outcomes produced using our methodology are always better.

[29] For robustness tests applied to poverty analysis, see, for example, Bishop et al. (1996), Foster and Shorrocks (1988), Jenkins and Lambert (1997), and Ravallion (1992).

to note that this range of poverty lines includes all those estimated for Tunisia.[30] Nonetheless, if it is relevant to set the cut-off poverty beyond the limit of 540 DT, the outcome becomes equivocal and FOD is unable to rank the relative effectiveness of the p-type transfer in alleviating poverty.

Considering that these two schemes cannot be ranked by FOD, it is possible to order them by second-order dominance (SOD). A fall in poverty with p-type transfers requires that the poverty deficit measure for the post-reform distribution is not higher than that for the status quo everywhere among the range variation of z_e, that is:

$$\Delta P_1(.) = P_1(z_e, y + M) - P_1(z_e, y + T^{II}) \geq 0 \qquad (12)$$

for all z_e with at least one strict inequality. As we are simulating a revenue-neutral reform, this difference is equal to the cost reduction of awarding the non-targeted group, that is the decrease of leakages. Figure 2 illustrates the relationship of universal FSP and p-type transfers to SOD and the cumulative poverty deficit variation.

Figure 4 shows that direct transfers based on targeting by indicators second-order-dominates indirect transfers based on targeting by commodities, even up to an equivalent poverty line equalizing 1800 DT. Since the cumulative benefits with targeting by indicators are positive at each equivalent poverty line up to 1800 DT, we can argue that the proposed design is more effective in decreasing the poverty deficit; and this holds for all poverty measures with $\alpha \geq 1$. The need to test higher orders of dominance becomes really thin since the hypothesis of an equivalent poverty line exceeding the limit of 1800 DT is arguably far from being plausible.

4. Conclusion

The FSP is one of the most important tools for alleviating poverty in Tunisia, but its effects are not well understood. The presence of this scheme makes the poverty problem less serious than it should appear in official statistics. This paper is partly concerned with this issue. Notwithstanding, even if the FSP lessens poverty, looking for alternative design to improve targeting accuracy of limited resources is always one of the most important objectives of policymakers.

To achieve these goals, the second section presents a methodology, which enables the evaluation of the food subsidy effects on the poor population's welfare. It consists in computing the King's (1983) equivalent income gain for each household, in the available sample, which results from the current program. The distribution of these gains could be so aggregated to capture the poverty reduction achieved under the current scheme. This analysis reveals that the FSP is certainly a meaningful source of welfare improvement for the poor. Yet it entails a considerable excess burden and benefits the rich more than the poor in absolute terms. For instance, the richest quintile of the population receives 2.2 times more of the equivalent gains from food subsidies than the poorest quintile. Moreover, non-parametric estimations suggest that there are no commodities predominantly consumed by the poor. This precludes the targeting by commodities option to enhance poverty reduction and so, it becomes appealing to look for an alternative option, like the targeting by indicators one, to reach this objective.

For the purpose of assessing to what extent proxy means tests could raise the poorest share of the available budget, the third section suggests a new approach to target p-type direct transfers. Whereas it overcomes some drawbacks of the main previous methods, this approach is also theoretically plausible. More precisely, since it is optimal to awarding the available budget so as to equalize the $(\alpha - 1)^{th}$ order poverty measures of the poorest subgroups, when the objective is to minimize the α^{th} order poverty measure, we suggest estimating straight the $(\alpha - 1)^{th}$ order poverty deficit of each household, conditional upon some of its characteristics. Results are appealing, giving evidence for the large possibilities of this method to enhance targeting accuracy. For instance, when only easily observed indicators are included to look for a p-type transfer design, results show that poverty could be reduced - from the original level given by the food subsidies scheme – at least by 15.8 percent for $\alpha = 0$ up to 30.6 percent for $\alpha = 2$[31].

In order to avoid diverse views on how to select the poverty line and poverty measure, dominance tests are also used to assess the likely effects of direct transfers derived from regional targeting on a wide range of poverty lines and poverty measures. The main result is that such transfers design would first-order-dominate the current FSP within a range of poverty lines including more than all those estimated for Tunisia. Thus, it is possible to conclude that providing assistance to the poor based on targeting by indicators should be more effective in alleviating poverty than targeting by commodities, regardless of the poverty measure chosen.

The methodology followed in this paper does not consider the opportunity for households to change the characteristics by which they could be targeted. For instance, by some effort or with some loss of utility, some characteristics could be altered or concealed by households attempting to receive a (greater) transfer. While it is feasible that the marginal benefit of doing so will outweigh the

[30] The official poverty line estimated (under the vector $\mathbf{p}^s$) by the National Statistic Institute and the World Bank (1995) is between 196 and 252 DT. Ayadi and Matoussi (1999) found that z is rather between 213 and 262 DT.

[31] In reality, poverty would fall even more if we consider the excess burden costs resulting from a food subsidies scheme.

marginal effort required, it is unlikely that the net benefit of such behavior will be always non-negative. It is also not excluded that some non-poor households would avoid to masquerade as poor, because of the psychic costs of the social stigma resulting from the participation in programs meant specifically for the poor [Besley and Kanbur (1993)]. These issues will make up the subject of the extended investigations that this study will comprise.

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Figure 1: Share of Equivalent Gain

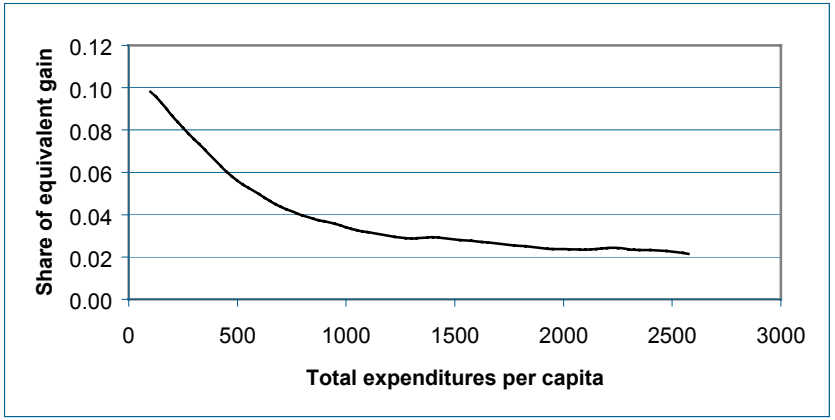

Figure 2: Non-parametric Regressions of Engel's Curves

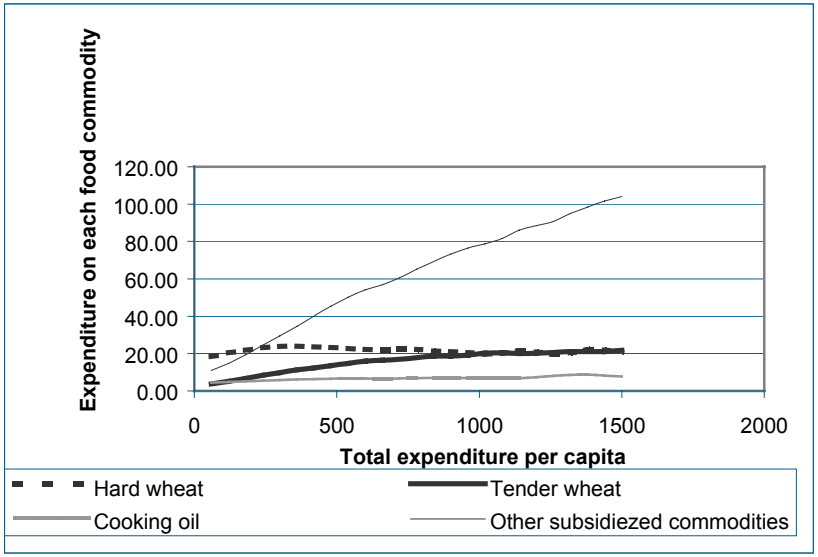

Figure 3: FOD

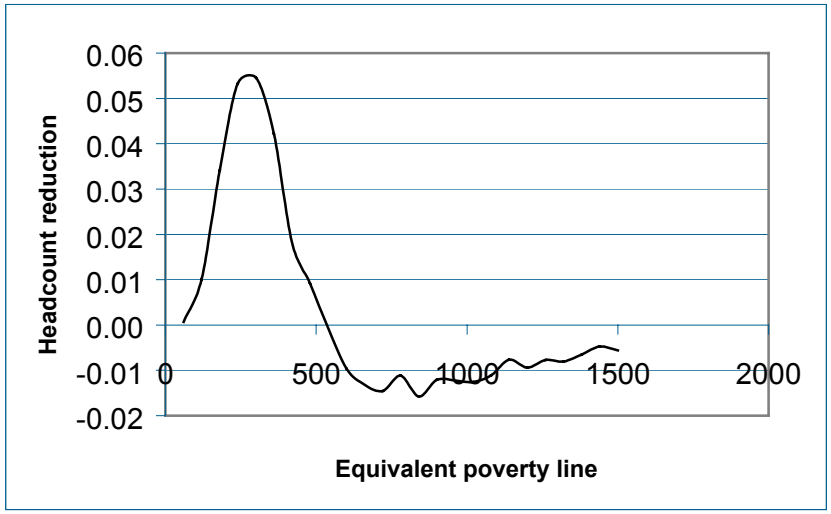

Figure 4: SOD

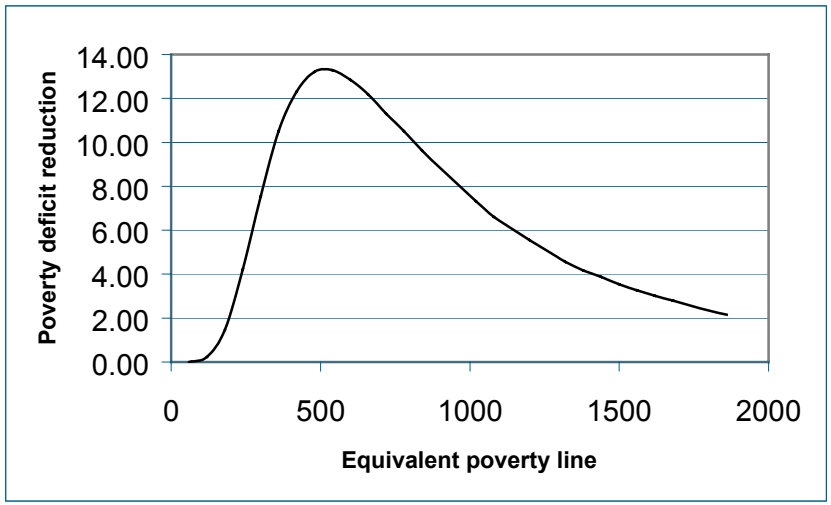

Table 1: Equivalent poverty lines

$z = e(p^p, 0)$	245	265	295	320	335
$z_e = e(p^o, 0)$	266	287	318	344	360

Table 2: Impact of Food Subsidies Scheme on Poverty*

α	z_e	$P_\alpha(\zeta_\varepsilon, \psi)$	$P_\alpha(\zeta_\varepsilon, \psi + E)$	$P\Delta_\alpha$)%(	κ
0	265	0.173	0.144	-17.02	-12.1
0	290	0.209	0.176	-15.65	-12.4
0	320	0.255	0.219	-13.98	-12.5
0	345	0.29	0.255	-11.99	-11.6
0	360	0.312	0.278	-11.03	-11.3
1	265	12.561	9.725	-22.58	-13.1
1	290	17.313	13.688	-20.9	-13.5
1	320	24.288	19.616	-19.26	-14.1
1	345	31.119	25.565	-17.85	-14.3
1	360	35.64	29.556	-17.08	-14.3
2	265	36.624	31.467	-14.08	-11.9
2	290	45.577	39.657	-12.98	-12.5
2	320	57.689	50.596	-12.29	-13.1
2	345	68.567	60.743	-11.41	-13.6
2	360	75.514	67.157	-11.07	-13.8
3	265	55.728	49.708	-10.8	-10.6
3	290	66.942	60.098	-10.22	-11.3
3	320	81.466	73.666	-9.57	-12
3	345	94.267	85.834	-8.95	-12.5
3	360	102.379	93.465	-8.71	-12.8

Notes: * For convenience, we report [Ra(.)](1/a) instead of Ra(.) for a ³ 1. So, if a = 2 (3), we have a quadratic (cubic) average of poverty deficit. Another attraction of this increasing monotonic transformation is that, since the inequality among the poor let [Ra(.)](1/a) > R1(.), the difference between [Ra(.)](1/a) and R1(.) could be interpreted as an overall cost of inequality. For more information about the advantages of this transformation, see Bibi (2001).

Table 3: Distribution of Equivalent and Maximum Gain from Food Subsidies Program *

Q_s	$\overline{y}_s$	$\overline{E}_s$	$\overline{M}_s$	$\sum_{Q_s} n^h E^h / B$	$\sum_{Q_s} n^h M^h / B$
Q_1	222.54	18.75	22.79	10.78 (10.78)	13.10 (13.10)
Q_2	378.51	25.34	30.56	14.57 (25.35)	17.57 (30.67)
Q_3	541.02	28.29	34.52	16.26 (41.61)	19.84 (50.51)
Q_4	771.08	31.22	38.75	17.94 (59.55)	22.27 (72.78)
Q_5	1590.64	41.25	47.33	23.72 (83.27)	27.22 (100.0)

Notes: *: Values between parentheses indicate the cumulative distribution of the variable under consideration.

Table 4: The opportunity cost of the deadweight loss in terms of poverty reduction

α	z_e	$P_\alpha(\zeta_\varepsilon, \psi + E)$	$P_\alpha(\zeta_\varepsilon, \psi + M)$	$P\Delta_\alpha$)%(	κ
0	265	0.144	0.138	-4.12	-2.5
0	290	0.176	0.169	-4.12	-2.9
0	320	0.219	0.211	-3.51	-2.8
0	345	0.255	0.25	-2.29	-2.0
0	360	0.278	0.271	-2.59	-2.4
1	265	9.725	9.169	-5.71	-2.7
1	290	13.688	13.021	-4.87	-2.8
1	320	19.616	18.72	-4.57	-2.8
1	345	25.565	24.495	-4.18	-2.9
1	360	29.556	28.378	-4.02	-2.9
2	265	31.467	30.446	-3.24	-2.5
2	290	39.657	38.363	-3.26	-2.6
2	320	50.596	49.159	-2.84	-2.7
2	345	60.743	59.155	-2.61	-2.8
2	360	67.157	65.496	-2.47	-2.8
3	265	49.708	48.42	-2.59	-2.2
3	290	60.098	58.716	-2.30	-2.4
3	320	73.666	72.02	-2.23	-2.5
3	345	85.834	84.128	-1.99	-2.6
3	360	93.465	91.65	-1.94	-2.7

Table 5: Impact on Poverty of Alternative Schemes

α	$P_\alpha(\zeta_\varepsilon, \psi + M)$	$P_\alpha(\zeta_\varepsilon, \psi)TP +$	$P_\alpha(\zeta_\varepsilon, \psi + T^I)$	$P_\alpha(\zeta_\varepsilon, \psi + T^{II})$
0	0.271	0.255^*	0.257^+	0.228^*
1	28.38	23.28^*	23.50^+	17.86^*
2	65.5	55.42^*	55.87^+	45.42^*
Leakages (%)	79.1	64.5	65.1	48.9

Notes: * Poverty difference between current and precedent simulation is significant at 1 percent level; + Poverty difference between current and precedent simulation is not significant, yet poverty difference between current simulation and targeting by commodities is significant at 1 percent level.