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Cahier de recherche/Working Paper **04-03**

Poverty-Decreasing Indirect Tax Reforms: Evidence from Tunisia

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Janvier/January 2004

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We thank CIRPÉE, SSHRC, the Chair of Canada in Social Policies and Human Resources, FQRSC, and the PEP programme of Canada's International Development Research Centre for financial support.

Abstract: This paper suggests a methodology to identify socially-desirable directions for poverty-alleviating tax reforms. The cost-benefit ratio of increasing any commodity-tax rate is derived from the minimization of a poverty measure subject to a revenue requirement for the government. Further, to avoid the arbitrariness of choosing a poverty line and a poverty measure, the search for a poverty-reducing tax reform is done "robustly", among other things by increasing progressively the ethical content of a pre-defined class of poverty measures. The methodology is illustrated using data from Tunisia. The results suggest that poverty could be dropped for a large class of poverty indices and a wide range of poverty lines by raising - at constant fiscal revenue - the subsidy rate on hard wheat and mixed oils and by decreasing the one on sugar and milk.

Keywords: Poverty alleviation, Indirect taxation, Targeting, Tunisia

JEL Classification: D12, D63, H53, I32, I38

1 Introduction

It is common to model the setting of indirect taxes as a problem of maximizing a Bergson-Samuelson social welfare function under the constraint of generating some level of fiscal revenue for the government.[1] This approach has contributed in part to the development of a theory of optimal indirect taxation. One of the theory's basic ingredients is a socially-weighted cost-benefit ratio. This ratio involves economic efficiency considerations as well as distributional value judgements. Economic efficiency considerations take into account the fiscal impact of the behavioral reactions to changes in indirect taxes; distributional judgements weigh the gains and the losses of individuals that differ often markedly in living standards, preferences and socio-demographic characteristics.

The recent social welfare literature has often focussed on the well-being of the population of the poor[2], which leads to the problem of minimizing a poverty index subject to some fiscal revenue constraint for the government. In many developing countries, income transfer schemes for the poor are usually constrained by the lack of information that government agencies have on the distribution of well-being. This makes a system of *negative* indirect taxation – or subsidies – a predominant tool for social welfare policy in these countries. The problem of how to improve the design of indirect taxes and subsidies so as to meet both poverty and efficiency criteria then becomes an important element of poverty alleviation strategies[3].

It is well-known, however, that the measurement of poverty is to a large extent arbitrary. Measuring and comparing poverty require choosing selectively among a very large number of available poverty indices. It also involves using some arbitrary official or semi-official poverty line, or estimating some other non-official line through procedures that are typically sensitive to many crucial ethical and statistical assumptions. Hence, it is not surprising that designing indirect taxation on the basis of such poverty assessment may also be considered arbitrary[4]. The paper's main objective is to illustrate how it may be possible to curb such degrees of arbitrariness by searching for tax reforms that are necessarily poverty reducing for a range of poverty lines and for classes of poverty indices of some ethical order.

To do this, the paper follows closely the social efficiency approach recently developed by Bibi (2001) and Duclos, Makdissi and Wodon (2002). Unlike Duc-

[1] See, among many others, Diamond (1975), Ahmad and Stern (1984, 1991), Baccouche and Laisney (1986), and Deaton and Grimard (1992).

[2] See, for instance, Blackorby and Donaldson (1980) and Atkinson (1987) for a discussion of the use of poverty measures as social utility functions.

[3] This issue for Tunisia is partly summarized in World Bank (1996): "The Tunisian Government was then faced with a common policy dilemma in reforming its subsidy program: how to reduce budgetary costs, in a politically acceptable way, while protecting low income groups."

[4] On this, see for instance Bibi (1998)

los *et al.* (2002), we use demand elasticity estimates to assess the marginal economic efficiency of various sources of tax revenues. We are therefore able to identify truly poverty-decreasing tax reforms. Unlike Bibi's (2001) approach, which is conditioned on the choice of a predetermined poverty measure, we search for poverty-reducing reforms over classes of poverty aggregation procedures. The paper also builds on the important contributions of Yitzhaki and Slemrod (1991), Mayshar and Yitzhaki (1995), and Yitzhaki and Lewis (1996). However, unlike these papers, which focus on second-order welfare improving tax reforms, this one censors well-being at (varying) poverty lines and also considers poverty-reducing tax reforms for various orders of ethical principles. Applying the methodology to Tunisian data, we find that poverty could be robustly reduced at constant fiscal revenue by increasing subsidy rate on hard wheat and mixed oils and lowering subsidy on sugar and milk.

The rest of the paper is structured as follows. Section (2) links poverty alleviation and indirect taxation. Section (3) describes how to check for the ethical robustness of the impact of indirect tax reforms on poverty. Section (4) applies the methodology using a Tunisian household budget survey, and Section (5) concludes the paper.

2 Poverty and indirect taxation

Let $\mathbf{p}$ and $\mathbf{t}$ be K-vectors of consumer prices and tax rates, respectively. For simplicity, we take producer prices to be invariant to changes in $\mathbf{t}$ and we normalize them to 1. We therefore have $p_k = 1 + t_k$ and $dp_k = dt_k$, where p_k and t_k are respectively commodity k's consumer price and indirect tax rate. A good k is subsidized when $t_k < 0$. Let $\mathbf{x}(y, \omega; \mathbf{p})$ be a vector of K quantities of commodities purchased by a consumer facing prices $\mathbf{p}$ and having an exogenous income y and some preferences ω.

Since we wish to assess the poverty effects of marginal price changes and marginal tax reforms, we must use a consumer's indicator of well-being that is sensitive to changes in prices and tax rates. A useful formulation is King's (1983) equivalent income function, $y_e\left(y, \omega; \mathbf{p}^r, \mathbf{p}\right)$, which is defined implicitly by:

$$v(y_e\left(y, \omega; \mathbf{p}^r, \mathbf{p}\right), \omega, \mathbf{p}^r) \equiv v(y, \omega, p), \tag{1}$$

where $v(\cdot)$ is the consumer's indirect utility function, $\mathbf{p}^r$ is a vector of reference prices, and y_e is the expenditure which yields the same utility level under $\mathbf{p}^r$ as y provides under $\mathbf{p}$. Notice that y_e is an exact monetary metric of actual utility since it is an increasing monotonic transformation of $v(y, \omega, p)$. y_e can also be usefully interpreted as a real expenditure function defined in reference to the prices $\mathbf{p}^r$. Inverting (1) yields $y_e\,(y,\omega;\mathbf{p}^r,\mathbf{p})$.

To describe how poverty is affected by changes in $\mathbf{t}$, we must also obviously address the measurement of poverty. Sen's (1976) influential work has generated a considerable literature on this[5]. We start with the popular Foster-Greer-Thorbecke (1984) (FGT) class of poverty indices, although an important aim of this paper is rather to show how the use of these peculiar indices is also useful for predicting how many other indices will react to tax changes. Let z be a real poverty line, that is, a line measured in terms of the reference prices $\mathbf{p}^r$.[6] The FGT class is then defined as

$$P_\alpha(z) \quad = \quad \int_0^{+\infty} \left(\frac{z-y_e}{z}\right)_+^\alpha dF(y_e), \tag{2}$$

where $f_+ = \max(0,f)$ and where $F(y_e)$ is the distribution of real or equivalent income y_e.[7] α is a parameter that captures the "aversion to poverty" or the distribution sensitivity of the index[8]. The FGT indices are averages of powers of normalized poverty gaps, $(z-y)_+/z$. As is well known, $P_0(z)$ is the poverty headcount (the "incidence" of poverty), $P_1(z)$ is the normalized average poverty gap measure (the "intensity" of poverty), and $P_2(z)$ is often described as an index of the "severity" of poverty – it weights poverty gaps by poverty gaps. For $\alpha > 1$, $P_\alpha(z)$ is sensitive to the distribution of living standards among the poor, and when α becomes very large, $P_\alpha(z)$ approaches a Rawlsian measure.[9]

Let government revenue from indirect taxation be denoted by

$$R(\mathbf{t}) \equiv \int_0^\infty \sum_{k=1}^K t_k x_k(y;p)dF(y), \tag{3}$$

where $x_k(y;\mathbf{p})$ denotes the expected consumption[10] of commodity k at income y, and where $F(y)$ is the distribution of nominal expenditures. As mentioned above, we constrain $R(\mathbf{t})$ to remain unaffected by our tax reforms: these reforms are thus revenue-neutral. The optimal design of an indirect tax system may then be formally

[5] For recent surveys of the literature on the axiomatic foundations and the design of poverty indices, see, for instance, Zheng (1997, 2000).

[6] In terms of (1), if v_z is the minimal level of utility required to live a decent live, then $v(z,\omega,\mathbf{p}^r) \equiv v_z$ for all ω.

[7] The use of equivalent incomes in the FGT measures can also be found, for instance, in Besley and Kanbur (1988) and in Ravallion and van de Walle (1991).

[8] See Zheng (2000) for a more elaborate discussion of this.

[9] See Rawls (1971).

[10] $x_k(y;\mathbf{p}) = \int_\Omega x_k(y,\omega;\mathbf{p})dF(\omega\,|y)$, with $F(\omega\,|y)$ being the conditional distribution of preferences and Ω the set of all possible preferences.

described by the solution to the problem of minimizing a poverty index subject to constant overall indirect tax revenues.

We are not, however, interested in identifying *the* optimal tax system, which would necessarily depend on the nature of the poverty index and poverty line chosen. Rather, we seek tax reform directions that will decrease poverty for a wide class of poverty indices and poverty lines. The search for such directions will nevertheless be guided by the first-order derivatives of both $P_\alpha(z)$ and $R(\mathbf{t})$ with respect to t_k.

To see this, let $x_k(\mathbf{p})$ be the *per capita* consumption of good k, E^k be the marginal efficiency cost of funds (MECF) from taxing good k [11], and $D_\alpha^k(z)$ be the poverty cost of raising t_k expressed as a proportion of $x_k(\mathbf{p})$. E^k and $D_\alpha^k(z)$ are formally defined as

$$E^k = \frac{x_k(\mathbf{p})}{\partial R(\mathbf{t})/\partial t_k} \tag{4}$$

and

$$D_\alpha^k(z) = \frac{\partial P_\alpha(z)/\partial t_k}{x_k(\mathbf{p})}. \tag{5}$$

Note that $D_\alpha^k(z)$ can also be interpreted as a Feldstein's (1972) distributional characteristic of commodity k. The product of these two quantities gives $\lambda_\alpha^k(z)$, the poverty cost per marginal dollar of tax raised from increasing t_k:

$$\lambda_\alpha^k(z) = E^k \cdot D_\alpha^k(z) \equiv \frac{\partial P_\alpha(z)/\partial t_k}{\partial R(\mathbf{t})/\partial t_k}. \tag{6}$$

The larger the value of $D_\alpha^k(z)$, the greater the distributive cost of a t_k increase. The larger the value of E^k, the lower the revenue effectiveness of the tax change since the lower its impact on government revenue. Therefore, the larger the value of E^k, the larger the economic efficiency cost of a tax increase. $\lambda_\alpha^k(z)$ is an intuitive product of the distributive and of the efficiency costs of the tax change: it is the poverty cost of raising a marginal dollar of government revenue through an increase in t_k. Note that if E^k is negative, we are on a downward-sloping area of the Laffer curve and it is always necessarily better to reduce t_k.

Given this interpretation, it is not surprising that $\lambda_\alpha^k(z)$ plays a useful role in identifying poverty-reducing tax reforms. Indeed, what matters for designing poverty-alleviating revenue-neutral policy reforms are the comparative values of the $\lambda_\alpha^k(z)$ for different k. When $\lambda_\alpha^j(z) < \lambda_\alpha^l(z)$, poverty (as measured by $P_\alpha(z)$) can be dropped by raising one more dollar from t_j and one less dollar from t_l (thus keeping overall government revenue constant).

[11] See Mayshar and Yitzhaki (1995), Bibi (2001), and Duclos *et al.* (2002) for a discussion of this.

Let $\overline{x}_k(y;\mathbf{p})$ be consumption of k relative to average consumption, that is, $\overline{x}_k(y;\mathbf{p}) = x_k(y;\mathbf{p})/x_k(\mathbf{p})$. Using Roy's identity and setting reference prices to current consumption prices, $\mathbf{p}^r = \mathbf{p}$, it is then possible to show that [12]

$$D^k_\alpha(z) = \begin{cases} \overline{x}_k(z;\mathbf{p})f(z) & \text{if } \alpha = 0, \\ \alpha z^{-\alpha} \int_0^\infty \overline{x}_k(y;\mathbf{p})\,(z-y)_+^{\alpha-1}\,dF(y) & \text{if } \alpha > 0, \end{cases} \tag{7}$$

where $f(z)$ is the density of income at z. The interpretation of (7) depends on whether α is positive or equal to zero:

- With $\alpha = 0$, the poverty objective of a tax reform is to reduce the proportion of the population in poverty. Because the tax reforms we consider are marginal, it is only those at the margin of poverty that can be brought in or out of poverty by such a tax reform. It is therefore only the consumption profile $\mathbf{x}(z;\mathbf{p})$ of those at or just around z that matters in identifying headcount-reducing directions for marginal tax reforms. Seeking to reduce $P_0(z)$ could then lead to a reform that benefits more the richest of the poor but penalizes the poorest of them – an example of an *r-type* fiscal reform in Bourguignon and Fields's (1997) terminology. This could occur if the consumption profile of those close to z differs significantly from the consumption profile of poorer individuals.

- With $\alpha > 0$, every poor person's consumption counts, but not necessarily equally. The weights on the consumption $\overline{x}_j(y;\mathbf{p})$ are proportional to the poverty gaps $(z-y)_+^{\alpha-1}$. *Ceteris paribus*, the larger the value of α, the more socially costly it is to increase the tax rate on a commodity consumed mainly by the poorer. When a commodity is not consumed by the poor, there is no distributive cost in increasing its tax rate.

Since

$$dP_\alpha(z) = \sum_{k=1}^K \frac{\partial P_\alpha(z)}{\partial t_k} dt_k \tag{8}$$

and

$$dR(\mathbf{t}) = \sum_{k=1}^K \frac{\partial R(\mathbf{t})}{\partial t_k} dt_k, \tag{9}$$

and using (6), a poverty-decreasing and revenue-neutral marginal tax reform is then described by a vector $(\delta_1, \ldots, \delta_K)$ of marginal tax revenues $\delta_k = \partial R(\mathbf{t})/\partial t_k \cdot dt_k$

[12] The details can be found in the appendix.

for which

$$\begin{array}{rcl} dP_\alpha(z) & = & \sum_{k=1}^{K} \lambda_\alpha^k(z)\delta_k < 0 \\ & \text{and} & \\ dR(\mathbf{t}) & = & \sum_{k=1}^{K} \delta_k = 0. \end{array} \tag{10}$$

Once the $\lambda_\alpha^k(z)$ are estimated using (4), (5), (6) and (7), it is relatively straightforward to find out if there exists a vector of δ_k that can satisfy (10).

3 Robustness analysis

The above analysis clearly depends on the choice of a poverty index and of a poverty line. Since both of these choices are typically somewhat arbitrary, so will be the reform directions identified using them. We also saw that seeking reform directions on the basis of reducing one poverty index can lead to policies that penalize the poorest of the poor, and can thus raise important ethical issues.

Fortunately, it is often possible to curb such degrees of arbitrariness and inequity by searching for tax reforms that are necessarily poverty reducing for a range of z and for a class of ”acceptable” poverty indices. Such reforms may then be called *poverty improving*, in analogy to the references to Pareto-improving tax reforms in welfare economics. The acceptability of poverty indices will depend on whether they meet normative criteria of some ethical order. Each order of normative criteria defines a class of poverty measures. As the ethical order increases, the criteria put increasingly strong constraints on how poverty indices should rank distributions of living standards. Hence, we seek fiscal reforms that decrease poverty over a range of z and for various orders of ethical criteria for measuring poverty.

To see how to do this, consider the following general utilitarian formulation of a poverty evaluation function[13]:

$$P(z) = \int_\Omega \int_0^\infty \pi(y, \omega; z) dF(y, \omega), \tag{11}$$

where the $\pi(y, \omega; z)$ are the individual contributions to poverty[14]. A class $\Pi_s(z^*)$ of poverty evaluation functions (of ethical order s) can then be defined by putting restrictions on the properties of $\pi(y, \omega; z)$ and by imposing that $z \leq z^*$. A first natural normative property would seem to be that $\pi(y, \omega; z)$ be weakly decreasing in

[13]For expositional simplicity, we thus focus on additive poverty poverty indices. See *inter alia* Foster and Shorrocks (1988) for how non-additive evaluation functions could also be included in the analysis.

[14]A poverty evaluation function can be thought of as the negative of a social evaluation function censored at z – see Atkinson (1987) for instance.

y, whatever the level of y and whatever the value of ω. Because the ethical condition imposed for membership in that class is very weak – and is almost universally accepted[15] – we can consider that class to be of ethical order 0, and it can therefore be denoted as $\Pi_0(z^*)$.

More formally, assume that $\pi(y,\omega;z)$ is differentiable[16] with respect to y for all $y < z$, and denote by $\pi^{(s)}(y,\omega;z)$ the s-order derivative of $\pi(y,\omega;z)$ with respect to y. $\Pi_0(z^*)$ can then be defined as:

$$\Pi_0(z^*) = \left\{ P(z) \;\middle|\; \begin{array}{l} z \in [0, z^*], \\ \pi(y,\omega;z) = \pi(z,\omega;z) \text{ for } y > z, \\ \pi^{(1)}(y;z) \leq 0. \end{array} \right\} \tag{12}$$

The first line on the right of (12) defines the range of poverty lines that can be chosen to measure poverty. The second line on the right of (12) assumes that the poverty measures fulfill the well-known ”poverty focus axiom” – which states that changes in the living standards of the non-poor should not affect the poverty measure. The last line assumes that the $\Pi_0(z^*)$ indices are weakly decreasing in income. For a marginal reform not to increase any of the poverty functions that are members of $\Pi_0(z^*)$, it is then clear that it must not harm anyone whose income is at or below z^* – that is, it must be Pareto improving over that range of incomes. The usual Pareto criterion obtains when a tax reform must not increase any of the poverty indices that are members of $\Pi_0(\infty)$.

It has, however, long been recognized that searches for Pareto-improving tax reforms are generally doomed to failure, especially in a world of heterogenous preferences. For a tax reform to be Pareto improving, it must indeed not decrease anyone’s living standard, whatever one’s consumption preferences. This is unlikely to be possible, even if we constrain the relevant living standards to be below some z^*. The use of the Pareto criterion thus essentially gives a veto status to the *status quo*, whatever those existing tax systems may be. Because of this, a number of earlier studies have opted for imposing a particular form on the social evaluation functions and/or on the social weights on the well-being of individuals.[17]

The alternative route followed here is to design social-improvement criteria that are of ”higher” ethical order than the Pareto criterion. It would seem, for instance, that a plausible ethical judgement of higher order than the Pareto judgement would require that the social contributions $\pi(y,\omega;z)$ in (11) should not depend on

[15] A focus on relative poverty might seem to provide an exception to this, since an increase in a poor’s living standard could then increase the relative poverty line and possibly also increase the poverty index. But note that z is kept constant in the present discussion of the ethical criteria.

[16] This differentiability assumption is made for expositional simplicity and could be relaxed.

[17] See for instance King (1983), Ahmad and Stern (1991), and Deaton and Grimard (1992), which use a social weight that is smoothly decreasing in income.

the taste parameters ω, *viz*, we should have that $\pi(y, \omega; z) = \pi(y; z)$ whatever the value of ω. The social judgement is then *anonymous* in the ω, and (11) can be rewritten as $\int_0^\infty \pi(y; z) dF(y)$. Maintaining the earlier 0-order ethical assumptions, this defines the class $\Pi_1(z^*)$ of poverty evaluation functions:

$$\Pi_1(z^*) = \left\{ P(z) \,\middle|\, \begin{array}{l} P(z) \in \Pi_0(z^*) \\ \pi(y, \omega; z) = \pi(y; z) \text{ whenever } y \leq z. \end{array} \right\} \tag{13}$$

Duclos *et al.* (2002) describes a tax reform that decreases poverty for all poverty indices within $\Pi_1(\infty)$ as a Pen-improving tax reform[18]. Here, we are more concerned in a sense with *restricted* Pen-improving tax reforms, that is, with tax reforms that are Pen-improving over a $[0, z^*]$ range of living standards. Equivalently, these reforms can be described as first-order poverty-improving tax reforms. The results of Duclos *et al.* (2002) (see in particular their Theorem 1) can then be used to show that:

Theorem 1 *A necessary and sufficient condition for a marginal tax reform (described by the vector of marginal tax revenues δ_k) to be revenue neutral and first-order poverty-improving – that is, to decrease poverty weakly for all $P(z) \in \Pi_1(z^*)$ – is that*

$$\begin{array}{c} \sum_{k=1}^K \lambda_0^k(z) \delta_k \leq 0 \textit{ for all } z \in [0, z^*] \\ \textit{and} \\ \sum_{k=1}^K \delta_k = 0. \end{array} \tag{14}$$

If a tax reform is found not to satisfy (14), then its poverty impact is necessarily ambiguous. Some of the $P(z)$ in $\Pi_1(z^*)$ will declare the reform to worsen poverty, while others will indicate that the reform will reduce poverty. To resolve this ambiguity, and in general to facilitate the search for poverty-improving tax reforms, two avenues can be followed. The first is to reduce the size of the set of the potentially poor individuals by lowering z^*. The effect of this is not necessarily desirable if one does not wish to constrain too much the range of poverty lines that are admissible for making poverty comparisons. The second avenue is to search for tax reforms that are poverty improving over a higher-order class of poverty indices. As before, increasing the normative order of poverty indices is done by constraining poverty indices to fulfill additional ethical criteria.

To follow this second avenue, assume that poverty indices must fall weakly following a mean-preserving redistributive transfer from a richer to a poorer individual. This corresponds to imposing the well-known Pigou-Dalton criterion

[18] See Pen (1971). Bibi (2001) defines the Pen-improving tax reform as a reform which lessens the headcount ratio, regardless of the poverty line chosen.

on poverty indices, and thus to make the poverty analysis "distribution sensitive". Maintaining as before the earlier conditions, the class $\Pi_2(z^*)$ of poverty indices is obtained as:

$$\Pi_2(z^*) = \left\{ P(z) \;\middle|\; \begin{array}{l} P(z) \in \Pi^1(z^*), \\ \pi^{(2)}(y;z) \geq 0, \\ \pi(z;z) = 0, \end{array} \right\} \tag{15}$$

where the last line of (15) is a continuity condition that excludes indices that are discontinuous at the poverty line (like the headcount index).

The third-order class of poverty indices is analogously obtained by requiring that, for a given distance between recipients and donors, the poverty-reducing effect of equalizing transfers be decreasing in the income of the recipient. To see this more formally, let $y_r < z$ and y_d be respectively the income of the recipient and of the donor in a Pigou-Dalton redistributive transfer of size τ, with $y_d - y_r > \tau > 0$. Then, for a given value of τ, $P(z)$ must fall with y_r if $P(z)$ belongs to $\Pi_3(z^*)$. Assuming differentiability again, this condition can be expressed by the sign of the third-order derivative of $\pi(y;z)$:

$$\Pi_3(z^*) = \left\{ P(z) \;\middle|\; \begin{array}{l} P(z) \in \Pi^2(z^*), \\ \pi^{(3)}(y;z) \leq 0, \\ \pi^{(1)}(z;z) = 0. \end{array} \right\} \tag{16}$$

$\pi^{(3)}(y;z)$ being negative, the magnitude of $\pi^{(2)}(y;z)$ falls with y, and Pigou-Dalton transfers lose their poverty-reduction effectiveness as recipients become more affluent.

This process can be continued iteratively up to any desired ethical order s by putting appropriate restrictions on all derivatives up to $\pi^{(s)}(y;z)$. The ethically-consistent sign of a derivative $\pi^{(r)}(y;z)$ is given by the sign of $(-1)^r$. We can then use the results of Duclos *et al.* (2002) to show:

Theorem 2 *A necessary and sufficient condition for a marginal tax reform (described by the vector of marginal tax revenues δ_k) to be revenue neutral and s-order poverty-improving – that is, to decrease poverty weakly for all $P(z) \in \Pi_s(z^*)$ – is that*

$$\begin{array}{c} \sum_{k=1}^{K} \lambda_{s-1}^{k}(z)\delta_k \leq 0 \textit{ for all } z \in [0, z^*] \\ \textit{and} \\ \sum_{k=1}^{K} \delta_k = 0. \end{array} \tag{17}$$

One way to check the existence of poverty-improving tax reforms is simply to plot the different $\lambda_s^k(z)$ over the range of poverty lines $z \in [0, z^*]$. If the $\lambda_s^k(z)$ curves do not intersect for two $k = j, l$, then a marginal tax reform involving good

j and l can easily be constructed such as to decrease all of the poverty measures that belong to $\Pi_s(z^*)$. Note that this allows for the choice of any poverty line within $[0, z^*]$. $\Pi_1(z^*)$ includes basically all of the poverty indices that have been proposed (with the notable exceptions of the Sen (1976), Takayama (1979) and Kakwani (1980) indices) and that are in use. $\Pi_2(z^*)$ includes all of those in $\Pi_1(z^*)$ with the important exception of the headcount. $\Pi_3(z^*)$ further excludes indices such as the linear indices of Hagenaars (1987) and Duclos and Grégoire (2002).

To illustrate how the assessment of first-order poverty-improving tax reforms differs from that of second-order ones, assume that there are only two levels at which incomes are grouped, y_1 and y_2, with $y_1 < y_2 < z^*$. For a tax reform to be first-order improving, it should increase (*on average*) the living standard of each of these groups. This is, in a sense, equivalent to giving a veto to each group taken as an average. By contrast, using Theorem 2 and equation (10), a second-order improving tax reform will need to improve on average the poorest group's living standard as well as the overall mean living standard – but not necessarily the average living standard of the second group. This eliminates the second group's veto power. The reform could thus be second-order improving even if everyone in the richest group were to lose from it, providing that the gains of the poorest group were high enough.

4 Application to Tunisia

4.1 Estimation of a demand system

Implementing the methodology presented above requires information on the joint distribution of incomes and commodity consumption. This is readily obtained from household budget surveys. To search for first-order poverty-improving tax reforms, we further need estimates of the average commodity basket of those at or around the poverty line. We do this non parametrically using simple kernel estimation – see for instance Härdle (1990) and Silverman (1986). Implementation of the above methodology finally requires estimates of how commodity demands change in response to price variations in order to assess the expected impact of tax reforms on government revenue.

To make our estimates of aggregate demand behavior as flexible and as consistent as possible with disaggregated household behavior, we estimate the following demand system:

$$\begin{aligned} w_j(y;\mathbf{p}) &= \varrho_j + \textstyle\sum_{k=1}^K \theta_{jk} \ln p_k + \gamma_j \ln y + \mu_j (\ln y)^2 + \upsilon_j, \\ &\text{with} \\ \textstyle\sum_{k=1}^K \varrho_k &= 1, \theta_{jk} = \theta_{kj}, \textstyle\sum_{k=1}^K \theta_{jk} = \sum_{k=1}^K \gamma_k = \sum_{k=1}^K \mu_k = 0, \end{aligned} \tag{18}$$

and where $w_j(y;\mathbf{p})$ is the budget share of commodity j at y and υ_j is a residual term. Equation (18) looks very much like the "Quadratic Almost Ideal Demand System" (henceforth QAIDS) of Banks *et al.* (1997) in which budget shares are linear in θ_{jk}, γ_j, and μ_j. The estimation strategy follows Deaton (1988, 1990) and relies on the spatial variability of prices in Tunisia to estimate the price parameters θ_{jk} in (18).

The model described by equation (18) was used to estimate a demand system of fifteen food commodities. For this, we use the 1990 Tunisian 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 7734 households' behavior, education, housing, region of residence, demographic information, and economic activities. The detailed procedure and results of the estimation can be found in Bibi (2001). Table 1 in the appendix lists the fifteen goods, together with their own- and cross-price elasticities. The most estimated own-price elasticities are, as they should be, negative and statistically significant. The cross-elasticity signs confirm the intuitive substitutability between the various groups of food goods, such as the Cereals, Olive and Mixed-Oils groups, and between the different protein products such as the Meat, Fish and Poultry and Eggs groups.

We can use the results of Table 1 to predict the effects of tax reforms on government revenue. To do this, note that expected government revenue raised from indirect taxes at income y is given by

$$R(y;\mathbf{t}) = \sum_{k=1}^{K} \frac{t_k}{(1+t_k)} w_k(y;\mathbf{p})y. \tag{19}$$

Since $\frac{\partial w_k(y;\mathbf{p})}{\partial t_j} = \frac{\theta_{kj}}{1+t_j}$, it is possible to show that

$$\frac{\partial R(y;\mathbf{t})}{\partial t_j} = \frac{w_j(y;\mathbf{p})y}{(1+t_j)^2} + \frac{t_j y \theta_{jj}}{(1+t_j)^2} + \frac{1}{1+t_j}\sum_{k\neq j}\frac{t_k y \theta_{kj}}{1+t_k}. \tag{20}$$

Thus, the MECF (defined by (4)) from taxing good j could be rewritten as:

$$\begin{aligned} E^j &= \frac{\frac{1}{1+t_j} w_j(\mathbf{p}) \int_0^\infty y dF(y)}{\partial R(\mathbf{t})/\partial t_k} && (21) \\ &= \frac{1}{1 + \frac{t_j}{1+t_j}\left(\frac{\theta_{jj}}{w_j(\mathbf{p})} - 1\right) + \sum\limits_{k\neq j} \frac{t_k}{1+t_k}\frac{\theta_{kj}}{w_j(\mathbf{p})}} \end{aligned}$$

where $w_j(\mathbf{p})$ is the aggregate budget share of commodity j defined by:

$$w_j(\mathbf{p}) = \frac{\int_0^{+\infty} w_j(y;\mathbf{p}) y dF(y)}{\int_0^\infty y dF(y)}. \tag{22}$$

Let $\overline{w}_j(y;\mathbf{p})$ be the budget share of j relative to the aggregate budget share, that is, $\overline{w}_j(y;\mathbf{p}) = w_j(y;\mathbf{p})/w_j(\mathbf{p})$. It is possible to rewrite (7) as

$$D_\alpha^j(z) = \begin{cases} \overline{w}_j(z;\mathbf{p})zf(z) & \text{if } \alpha = 0, \\ \alpha z^{-\alpha}\int_0^\infty \overline{w}_j(y;\mathbf{p})\,(z-y)_+^{\alpha-1}\,ydF(y) & \text{if } \alpha > 0. \end{cases} \tag{23}$$

By (21) and (23), equation (6) can be expressed as:

$$\begin{aligned} \lambda_\alpha^j(z) &= \frac{D_\alpha^j(z)}{1 + \frac{t_j}{1+t_j}(\frac{\theta_{jj}}{\overline{w}_j} - 1) + \sum\limits_{k\neq j} \frac{t_k}{1+t_k}\frac{\theta_{kj}}{\overline{w}_j}} \\ &= \frac{D_\alpha^j(z)}{1 + \frac{t_j}{1+t_j}e_{jj} + \sum\limits_{k\neq j} \frac{t_k}{1+t_k}e_{kj}}, \end{aligned} \tag{24}$$

where e_{kj} is the cross-price elasticity of the commodity k relative to the price of the commodity j. The denominator (which is $1/E^j = \frac{\partial R(\mathbf{t})/\partial t_j}{x_j(\mathbf{p})}$) captures the marginal rise of tax revenue from increasing t_j. The second term of this denominator is the tax rate multiplied by the own-price elasticity. This gives an estimate of the own-price distortionary effect of t_j. If it is negative and large enough, as would be the case for heavily taxed elastic commodities, it contributes to a high value of λ^j. As a result, this commodity would be a costly candidate to increase fiscal revenue. The last factor in the denominator, that is, the sum of the tax rates multiplied by the cross-price elasticities, informs on the distortion resulting from the cross effects of the t_j variation on the other commodities. When taxes on all commodities are low, E^j approximates 1, and efficiency consideration then do not matter in searching for poverty-reducing fiscal reforms – only Feldstein's (1972) distributional characteristic are then important to consider.

4.2 Data and results

We focus our tax reform analysis on six commodities: *hard wheat*, *tender wheat*, *mixed oils*, *other subsidized goods* (poultry, eggs, milk and sugar), *non-taxed goods* (vegetables, fruit, meat, olive oils, and fish), and *taxed goods* (sweet foods, canned foods, other food commodities, and non-food commodities). A per-adult-equivalent poverty line of $z_e = 335$ Tunisian Dinars (TD) per year is used as a reference line[19]. This line corresponds to approximately 50% of mean total expenditure.

Table 2 reports the economic efficiency cost of raising tax on each of these commodities, E^k. Recall that this is the marginal economic efficiency cost of

[19] In 1990, 1 TD was worth approximately 1 US dollar.

public funds, and that it also equals 1 plus the marginal deadweight loss of one additional unit of tax revenue. Table 2 also shows the distributive cost $D_{\alpha}^{k}(z)$ and the overall poverty cost $\lambda_{\alpha}^{k}(z)$ per TD of marginal tax revenue raised from taxation of the different commodities.

Two groups of commodities clearly strike out of Table 2. The first group includes *tender wheat*, *hard wheat*, and *mixed oils*. The second regroups the *other subsidized goods*, *non-taxed goods*, and *taxed goods*. Commodities of the first group are a good target for tax decreases (or subsidy rises) as they show the highest distributive cost and economic efficiency. The reverse is true for commodities of the second group: they are a good target for tax rises or subsidy falls. A fall in the taxation of anyone of the commodities of the first group combined with a revenue-neutral rise in the taxation of any of the commodities of the second group would be poverty decreasing.

Note that the ranking of commodities in terms of economic, distributive and overall poverty cost is the same regardless of the choice of α. The poverty cost of marginal tax revenues is highest for *mixed oils* and lowest for *taxed goods*. Hence, the largest poverty decrease per TD of reallocated government budget would be obtained from increasing the subsidies on *mixed oils* while further increasing the tax on the *taxed goods*.

Whether these poverty-decreasing reforms are robust to the choice of poverty lines and indices depends on whether the ordering of the $\lambda_{\alpha}^{k}(z)$ is sensitive to the choice of the poverty line z_e. Figure 1 displays the estimates of the $\lambda_{0}^{k}(z)$ in order to search for first-order poverty-improving tax reforms. Many of the $\lambda_{0}^{k}(z)$ curves do intersect. Restricting the upper limit for poverty lines to 900 TD[20], we find that a tax rise on any one of the second group of commodities to finance a subsidy rise on any one of the first group of commodities is poverty improving. Figure 2 also shows that such directions for reform are second-order poverty improving whatever the upper bound for poverty lines, and thus that they are Dalton improving in the social welfare terminology of Mayshar and Yitzhaki (1995). So there is no need to test at a higher ethical order for such tax reforms in Tunisia.

It is perhaps instructive to point out that many studies have indeed suggested reductions in the subsidy rates on *tender wheat* and on commodities within the *other subsidized goods* in order to increase subsidy rates on *hard wheat* and *mixed oils*.[21] The framework developed above enables us to check the robustness of such recommendations.

Table 3 reports the upper poverty line until which the ordinal rank of each of the $\lambda_{\alpha}^{k}(z)$ among the first set of commodities remains unchanged. As reported in the

[20] 77.5% of the Tunisian population have their total annual expenditures below that bound.

[21] See, for instance, Newbery (1995) and Tuck and Lindert (1996).

table, increasing the rate of subsidy on mixed oils is first-order poverty improving so long as the poverty lines do not exceed 275 TD.[22] The reform is second-order improving for all poverty lines up to 450 TD. Since it is difficult to rule out all poverty lines above 190 TD, decreasing subsidies on *tender wheat* in order to increase them on *hard wheat* cannot be safely declared first-order poverty improving, although it seems safe to see such a reform as higher-order poverty improving.

Policymakers and policy analysts often look for tax reform directions that improve the well-being of a majority of citizens. It is thus interesting to display graphically the cumulative percentage of gainers from two hypothetical scenarios of (*restricted*) Pen-improving reforms. Scenario 1 (2) suggests reductions in the subsidy rate on *tender wheat* (on commodities within the *other subsidized goods*) in order to increase subsidy rate on *mixed oils*. Figure 3 shows that scenario 1 could be politically difficult to implement since the proportion of winners never reaches 50 percent of the population. However, in addition to be a Pen-improving tax reform, scenario 2 would also be popular since it would meet the approval of more than 70 percent of the population.

5 Conclusion

This paper relates indirect taxation policy to poverty alleviation. The approach extends the framework of Mayshar and Yitzhaki (1995) to any degree of ethical dominance and allows the analyst to censor welfare at a given poverty line so that the emphasis is made on poverty alleviation rather than social welfare improvement. The method can be used to test the extent to which tax reforms can be used to decrease poverty, for large classes of poverty indices and for ranges of possible poverty lines.

The empirical illustration is made using household survey from Tunisia. It tests *inter alia* the claim of many earlier studies that reducing the rate of subsidy on *tender wheat* and increasing that on *hard wheat* and *mixed oils* would improved the targeting of Tunisia's food subsidy system and help alleviate poverty. This paper's framework indicates that such a reform would not be confidently first-order poverty improving, but would be (second-order) poverty reducing if we forced our poverty analysis to be distribution sensitive.

[22] The "official" poverty lines estimated by *l'Institut National de la Statistique* and the World Bank are 218 TD per person per year for the urban areas and 185 TD for the rural areas. See World Bank (1995) on this.

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6 Appendix

The FGT class of poverty measures can be writen as:

$$P_\alpha(z) = \int_0^{+\infty} g_\alpha(z, y_e(y; \mathbf{p}^r, \mathbf{p})) dF(y) \tag{25}$$

where

$$g_\alpha(z, y_e) = \left(\frac{z - y_e}{z}\right)_+^\alpha, \tag{26}$$

where $F(y)$ is the distribution of nominal income and $y_e(y; \mathbf{p}^r, \mathbf{p})$ is equivalent income (abstracting for simplicity from dependence on preferences). For $\alpha \neq 0$, the impact of a marginal variation of t_k on poverty is given by:

$$\frac{\partial P_\alpha(z)}{\partial t_k} = \int_0^{+\infty} \frac{\partial g_\alpha(z, y_e(y; \mathbf{p}^r, \mathbf{p}))}{\partial t_k} dF(y) \tag{27}$$

with

$$\begin{aligned} \frac{\partial g_\alpha(z, y_e)}{\partial t_k} &= -\alpha g_{\alpha-1}(z, y_e) \frac{\partial y_e}{\partial t_k} \\ &= \alpha g_{\alpha-1}(z, y_e) x_k(y; \mathbf{p}) \end{aligned} \tag{28}$$

when $\mathbf{p}^r = \mathbf{p}$. When $\alpha = 0$ and $\mathbf{p}^r = \mathbf{p}$, a limiting argument shows that

$$\frac{\partial P_0(z)}{\partial t_k} = -\frac{\partial F(y_e(z; \mathbf{p}^r, \mathbf{p}))}{\partial t_k} = x_k(z; \mathbf{p}) f(z). \tag{29}$$

Table 1: Own- and cross-price elasticities

	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_{i13}	e_{i14}	e_{i5}
Hard wheat	-2.23 (-11)	0.58 (6)	0.07 (1.8)			0.42 (3)		0.22 (3)	-0.14 (-4)					-0.1 (-1.6)	-0.25 (-36)
Tender wheat	1.2 (6)	-1.9 (-6)						-0.18 (-2)							0.3 (4)
Other cereals	0.3 (1.8)		-0.85 (-0.5)	0.48 (3.7)	-0.12 (-1.8)		0.24 (2.6)			0.06 (3.3)	0.27 (5.7)	-0.44 (-4.4)	-0.15 (-2.8)		-0.14 (-1.8)
Vegetables			0.08 (3.7)	-0.9 (9.6)		0.16 (1.9)									
Fruit			-0.06 (-1.8)		-1.75 (-21)			0.24 (4)	-0.04 (-1.8)						-0.11 (-1.8)
Meat	0.28 (3)			0.14 (1.9)		-0.56 (-4.3)	0.17 (3.2)	-0.1 (-2.1)	-0.06 (-3)				0.22 (7)		
Poultry and eggs			0.11 (2.6)			0.53 (3.2)	-0.63 (-3.7)						-0.26 (-5.3)		
Milk	0.35 (3.1)	-0.14 (-2)			0.18 (4.1)	-0.24 (-2.1)		-1.76 (-21)		0.02 (1.8)		0.21 (3)			
Sugar	-0.54 (-4.3)				-0.07 (-1.8)	-0.36 (-3)			-0.42 (-1.9)				0.11 (3.1)		
Sweet foods			0.34 (3.3)					0.35 (1.8)		-1 (-1.9)				0.88 (3)	
Mixed oils			0.23 (5.7)								-0.88 (-5.2)	0.24 (2.3)			-0.13 (-1.9)
Olive oils			-0.29 (-4.4)					0.37 (3)			0.18 (2.3)	-1.89 (-9.3)			0.48 (4.2)
Fish			-0.21 (-2.8)			2.03 (7.5)	-0.79 (-5.3)		0.17 (3.1)				-0.64 (-5)	0.21 (1.9)	
Canned foods										0.07 (3)			0.06 (1.9)	-0.67 (-6.6)	0.09 (2.1)
Other foods	-0.28 (-3.6)	0.16 (3.7)	-0.04 (-1.8)		-0.06 (-1.8)						-0.04 (-1.9)	0.2 (4.2)		0.06 (2.1)	-0.92 (-1.9)

N.B. Values between parentheses indicate the t-ratio. For expositional simplicity, we present only price elasticities that are significant at the traditional threshold of 5%.

Table 2: Searching for poverty-decreasing tax reforms ($z_e = 335$ TD)

Commodities	Economic cost E^k	Distributive cost $D^k_\alpha(z)$			Overall poverty cost $\lambda^k_\alpha(z)$		
		$\alpha = 0$	$\alpha = 1$	$\alpha = 2$	$\alpha = 0$	$\alpha = 1$	$\alpha = 2$
Tender wheat	0.72	1.03	0.93	0.86	0.74	0.67	0.62
Hard wheat	0.43	1.48	1.74	1.87	0.64	0.75	0.81
Mixed oils	0.66	1.28	1.43	1.53	0.84	0.94	1.02
Other sub. goods	0.24	0.83	0.73	0.67	0.20	0.17	0.16
Non-taxed goods	0.23	0.82	0.70	0.63	0.19	0.16	0.14
Taxed goods	0.22	0.56	0.47	0.43	0.16	0.14	0.12

Table 3: Maximal poverty lines for robust tax reforms (Values between parentheses show the change in the ordinal rank of the curves $\lambda^k_\alpha(z)$ at the indicated poverty line.)

	$\alpha = 0$	$\alpha = 1$	$\alpha = 2$	$\alpha = 3$
Mixed oils	275	450	600	700
	(1 $\longrightarrow$ 2)	(1 $\longrightarrow$ 2)	(1 $\longrightarrow$ 2)	(1 $\longrightarrow$ 2)
Hard wheat	190	300	390	450
	(2 $\longrightarrow$ 3)	(2 $\longrightarrow$ 3)	(2 $\longrightarrow$ 3)	(2 $\longrightarrow$ 3)
Tender Wheat	190	300	390	450
	(3 $\longrightarrow$ 2)	(3 $\longrightarrow$ 2)	(3 $\longrightarrow$ 2)	(3 $\longrightarrow$ 2)

Figure 1: First-order poverty-improving reforms

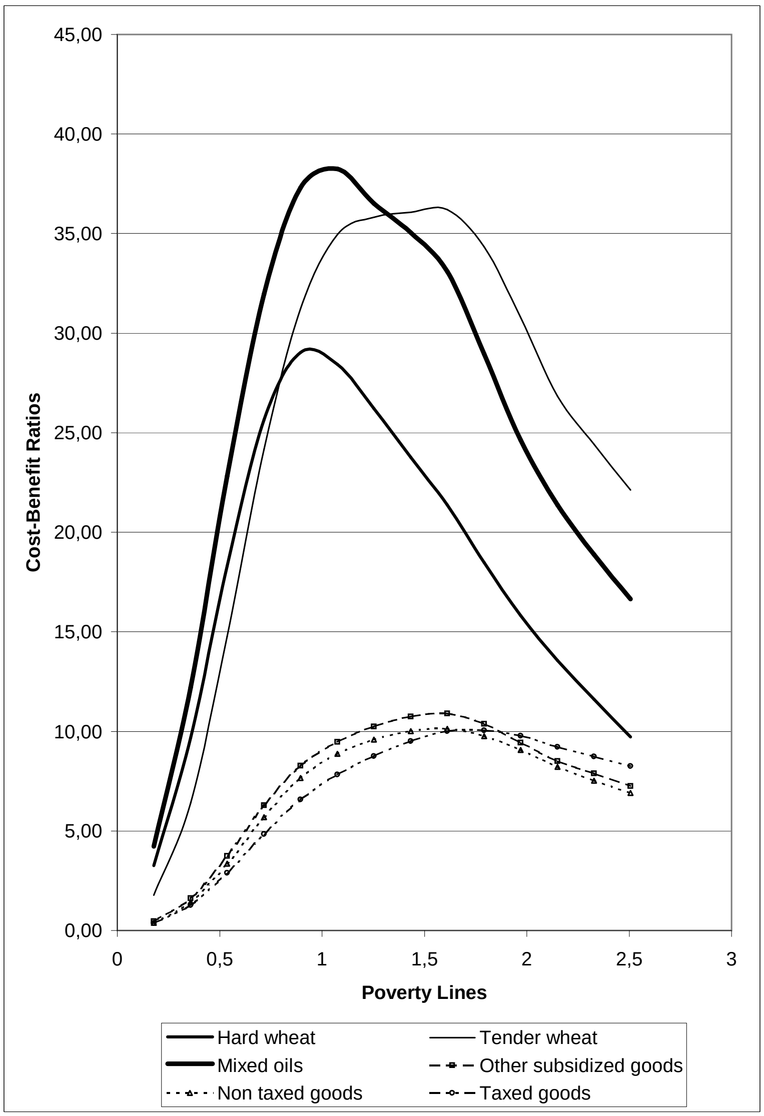

Figure 2: Second-order poverty-improving reforms

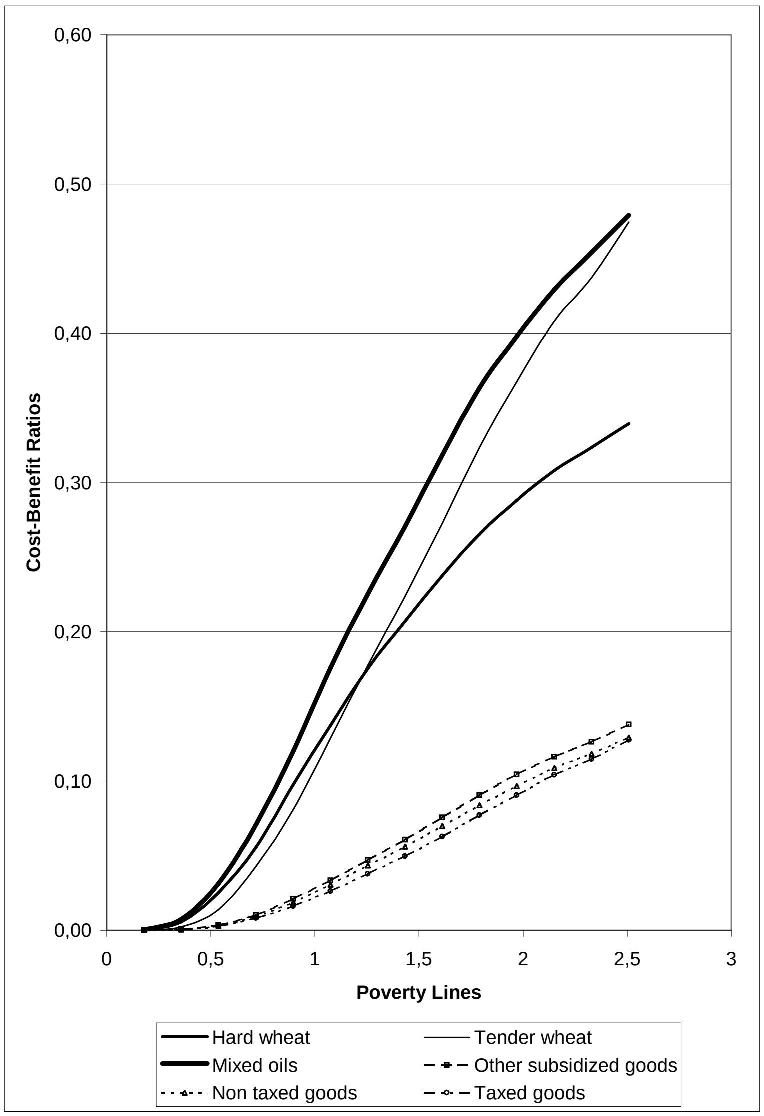

Figure 3: The proportion of gainers