The Poverty Impact of *Sin Taxes*

Evidence from Italy

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Abstract: This paper applies Consumption Dominance curve approach of Makdissi and Wodon to Italian Household Budget survey data in order to assess the poverty impact of *sin taxes* in Italy. Revenue neutral and non-neutral marginal tax changes are considered and their distributional aspects examined. Applying this methodology, we are able to identify the directions of indirect marginal tax reforms involving *sin goods* which would reduce poverty over a broad class of poverty measures and poverty lines. In particular, we show that a revenue-neutral combination of a fat tax with a subsidy on healthy food would be *pro-poor* regardless its distortionary effect.

JEL CODE: D12, I18, I32.

1. INTRODUCTION

In most western countries, governments levy specific taxes on goods, such as tobacco, alcohol, firearms, fatty food or frizzy drinks, whose consumption is proven to have a negative impact on the health of the consumer. These commodities are commonly labelled as *sin goods* and the specific fiscal measures applied to them are known as *sin taxes*.

While some goods have been explicitly taxed for a long time in order to correct the external costs related to their consumption (e.g. alcohol and tobacco), fiscal measures aimed at altering people's diets are quite recent. However, consistent with the increase in obesity rates impacting most western countries, fat and soda taxes are finding greater approval with many governments[1].

In the wake of this popularity, many recent studies investigate the overall effectiveness of fat and soda taxes in altering individual behaviour, and try to measure the health outcomes following their implementation. On the other hand, there exist few studies focusing on the distributional effects of *sin taxes*. This paper intends to fill this gap.

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[1] For a list of OECD countries which introduced taxes on unhealthy foods and beverages in 2011, see the Obesity Update 2012 available at http://www.oecd.org/els/healthpoliciesanddata/49716427.pdf

It is commonly believed that, similar to commodity taxes, *sin* excises mainly harm the less well-off in a society and, therefore, the introduction of new levies, as well as increases in the existing *sin tax* rates, raise equity concerns. However, in order to outline the distributional impact such peculiar indirect taxes actually have across the distribution of household monetary resources; a rigorous policy analysis is needed.

Given the topical debate about the implementation of new *sin taxes* in Italy and the availability of Italian data, this work carries out a social evaluation of marginal tax reforms involving *sin goods* within the Italian context. Specifically, the final purpose of the paper is to examine the poverty impact of changing the prices of five specific goods (or aggregates of goods) on a wide range of indexes commonly used in poverty analysis.

The commodities under observation will be tobacco, alcoholic drinks, carbonated beverages, fatty food and healthy food. Though the latter does not belong to the category of *sin goods,* it is included in the analysis to evaluate the poverty effects of revenue neutral tax reforms involving higher taxes on harmful goods accompanied by subsidies on products beneficial for consumers' health. Finally, in order to understand whether these tax changes would have had different distributional effects across time, the consumption pattern of Italian households over the past decade will be monitored.

The main analytical tool adopted in this study are Consumption Dominance Curves, a graphical approach to evaluation of commodity tax reforms recently presented in literature by Makdissi and Wodon (2002). This new methodology derives from stochastic dominance techniques and presents major advantages in comparison with the traditional approach to marginal commodity tax reforms (Ahmad and Stern (1984) and Besley and Kanbur (1988)). Essentially, consumption dominance analysis not only is less data demanding, since it does not require an accurate estimation of commodity demand responses to varying prices, but also less open to criticism, as its results are not conditional on researcher's preliminary choice of a social evaluation function. Finally, stochastic dominance techniques allow the typical limitation of traditional relative poverty analysis to be overcome. Indeed, consumption dominance curves permit the evaluation of the impact on poverty levels over a range of plausible poverty lines.

This paper represents the first attempt to establish the poverty effects of *sin taxes* in Italy and no prior study applying consumption dominance methodology to Italian data has been found. Hence, it represents a new contribution to research in the field of taxation studies.

The work is organised as follows. Section two provides a quick discussion of the major approaches to evaluating the social impact of marginal tax reforms and a detailed description of the analytical tools adopted in this study. In section three, the data and some preliminary summary statistics are discussed along with some insight into Italian households' consumption patterns of *sin* *goods.* In order to outline how the consumption of these goods is distributed across the distribution of monetary resources, parametrical and non-parametrical Engel Curves are estimated.

The key results of the paper are given in section four where distributional characteristics and consumption dominance curves for tobacco, alcohol, carbonated drinks, healthy and unhealthy food are presented. Despite being a key instrument in evaluating equity impacts of any price change, distributional coefficients are conditional on a social evaluation function preliminarily chosen by the analyst. Therefore the results are affected by some arbitrariness. In order to circumvent this problem, consumption dominance curves are estimated and the "poverty efficiency" of a large set of marginal tax reforms involving *sin goods* discussed.

The full analysis is carried out both at national and local level so that any meaningful cross-regional difference in consumption habits, and then in the possible social impact of *sin taxes*, is highlighted. The last section concludes.

2. THE EVALUATION OF TAX REFORMS.

Tax reform proposals should always go with and be supported by a careful policy analysis as their implementation necessarily leads to substantial changes in welfare allocation that, unless the reform is Pareto improving, will define winners and losers amongst economic agents depending on their role in the economy. In particular, since the implementation of an indirect tax reform directly affects commodity prices, it may have considerable impacts on households' welfare according to their consumption habits and their disposal of monetary resources.

Generally speaking, as less well-off families spend bigger shares of resources on purchasing goods and have lower saving rates than wealthy households, they are likely to be more affected by increases in indirect taxation. Hence, the introduction of new excises as well as increases in commodity tax rates already in place are measures commonly blamed to be regressive (Decoster et al (2010)). However, in order to understand what redistributive impacts any tax rate change would actually have on the population, a deeper policy analysis is needed.

Since evaluating non-marginal tax reforms is associated with serious methodological difficulties, such as the data demanding calculation of explicit consumer's welfare change (i.e. equivalent variation or compensated variation) or the results sensitivity to theoretical and econometric assumptions (Ray (1986)), many researchers have turned their focus of interest towards marginal tax reforms.

After the pioneering work of Ahmad and Stern (1984), who defined marginal commodity tax reforms as vectors of welfare-improving and revenue-neutral small tax changes, the literature on this subject has rapidly grown. Santoro (2007) provides a concise but comprehensive review about its developments and essentially outlines two main paths that the evaluation of marginal tax reforms has followed.

The most common approach, descending from Ahmad and Stern (1984), allows for evaluating the social impact of tax reforms directly from the data, without requiring estimates of individual demand and utility functions. However, in order to assess possible tax changes in terms of equity and efficiency, the researcher must choose a specific social evaluation function. It follows that the results are sensitive to the analyst's choice and, given that any particular functional form embodies arbitrary value judgements (e.g. a different degree of inequality aversion), a different social evaluation function may lead to different results.

A powerful analytical instrument related to this approach is the *distributional characteristics*, described in detail in the next section and widely used for highlighting the equity impacts of any commodity price change.

Despite its popularity, the lack of a unique view exposes this methodology to many criticisms.

The second route to tax reform evaluation tries to circumvent this limitation by using stochastic dominance tests. In this case, the analyst looks for "socially efficient" tax reforms, as Duclos, Makdissi and Wodon (2008) call the policies responsible for improvements in social welfare as well as reductions in the inequality or poverty level. This approach is similar in spirit to testing for Lorenz and Generalised Lorenz Dominance or for poverty dominance when two income or expenditure distributions are compared. Indeed, in order to verify whether a policy is desirable, the researcher relies on graphical tools and checks whether it would be unanimously approved by all those who agree with some generally defined normative properties of a social evaluation function. Increasing orders of stochastic dominance correspond to more specific and restrictive social welfare or poverty measures[2].

About the evaluation of marginal tax reforms, the first stochastic dominance test was introduced by Yitzhaki and Thirsk (1990) and Yitzhaki and Slemrod (1991).

This approach posits that welfare changes due to revenue neutral commodity tax changes can be assessed by comparing the standard concentration curves of two goods over the entire distribution of monetary resources[3]. Yitzhaki and Slemrod (1991) prove that whether the concentration curve of one commodity is above the concentration curve of another commodity, then the first commodity

[2]For an illustration of poverty dominance analysis and the respective properties of poverty indexes by increasing orders of dominance see Atkinson (1987) and for an application of poverty stochastic dominance approach see Madden and Smith (2000).

[3] Precisely, the concentration curve is a diagram similar to the Lorenz curve: on the horizontal axis, the households are ordered according to their monetary resources, while the vertical axis describes the cumulative percentage of total expenditure on a specific commodity that is spent by families whose incomes are less than or equal to the specified income level.

dominates the second and a marginal tax decrease in the former funded by a marginal tax increase in the latter would lead to a social welfare increase (conditional on efficiency effects).

About ten years later, Makdissi and Wodon introduced in the literature a new type of stochastic dominance test (Makdissi and Wodon (2002)) which relies on the comparison of "*consumption dominance curves*". Unlike concentration curves, they can be used to test for the impact on poverty of indirect tax reforms for restricted orders of dominance higher than two. Consumption dominance curves represent the most recent developments in the literature on marginal commodity tax reforms and allow for the evaluation of tax change impact on a wide class of additive poverty measures. When this approach is adopted, indirect tax reforms are interpreted in terms of poverty-reducing reforms.

This work embraces the latter methodology and the final purpose is the assessment of the "poverty efficiency" of a series of tax changes involving *sin goods* by looking at whether they can be labelled *pro* or *anti poor.*

The definition of *pro* (or *anti*) *poorness* of a tax reform has been recently given by Duclos, Makdissi and Araar (2009) in its relative and absolute meanings: a tax decrease (increase) is said to be "relatively *pro-poor"* (*anti-poor*) if its benefits (harms) accrue proportionally more to the poor than the non-poor. Similarly, a tax decrease (increase) is "absolutely *pro-poor"* (*anti-poor*) if it benefits (harms) the poor by a greater absolute amount than the non-poor.

By testing for poverty social improvement, conditions are less stringent than for "welfare improving tax reforms" because the focus of the evaluation is restricted to the impact of changing prices on households collocated below a maximum admissible poverty line, whereas welfare improvement analysis must take into account the entire population. In order to reduce the arbitrariness arising from the choice of the poverty line, a reasonably wide range of poverty thresholds will be considered.

Before illustrating the empirical results, two brief methodological notes are provided in order to clarify the approaches adopted here.

2.1 Distributional Characteristics.

Distributional coefficients, first introduced by Feldstein (1972), are a valid instrument in evaluating equity impacts of any price change since they allow to understand how the consumption of commodities is distributed across households' monetary resource distribution. However, these coefficients are just partially informative as they only encompass equity concerns whereas tax reforms might be driven by other considerations such as efficiency issues and accounting of spillover effects.

Essentially, it is the ranking of the goods by the distributional characteristics that is informative, not their absolute value. This varies indeed according to the extent to which the researcher concerns about less well-off families whereas the ranking reveals if the consumption of good i is more concentrated than good *j* among low income households. In short, the higher the distributional characteristic for a good, the more it is consumed by less well-off families.

A quick glance at the formula commonly used to compute distributional characteristics makes easier to understand this point:

$$D_i = \frac{\sum_{h=1}^{H} \beta^h x_i^h}{\sum_{h=1}^{H} x_i^h} = \frac{\sum_{h=1}^{H} \beta^h x_i^h}{X_i}$$

where *H* represents the number of households in the population and x_i^h denotes the consumption of good *i* by household *h*. Total consumption of good *i* is Xi $= \sum_{h=1}^{H} x_i^h$.

However, the key parameter is β^h, representing the social marginal utility of income (or expenditure) of household *h*. It depends on the social evaluation function adopted by the analyst: precisely, it stands for the relative weight attached to each family and varies according to the researcher's aversion to inequality. As a rule of thumb, the more inequality averse the analyst, the larger (in relative terms) the welfare weights β^h attached to poor households. Therefore, the distributional characteristic for good *i* is given by the ratio of the weighted total consumption of *i* and its simple total consumption.

The most frequent approach to calculate the relative welfare weights β^h involves the use of the monetary utility function proposed by Atkinson (1970):

$$U^h(Y^h) = \frac{k(Y^h)^{1-v}}{1-v}\ , v \neq 1 \quad \text{and} \quad U^h(Y^h) = \log Y^h, \text{v} = 1.$$

The values of β^h reflect household *h*'s marginal utility of the monetary measure adopted in the analysis Y. It follows that $\beta^h = \frac{\partial U^h}{\partial Y^h} = k(Y^h)^{-v}$, if $v \neq 1$ and $\beta^h = \frac{\partial U^h}{\partial Y^h} = \frac{1}{Y^h}$, if $v = 1$.

In order to obtain each household's welfare weight relative to the poorest household, we compute $\frac{\beta^h}{\beta^1} = \left(\frac{Y^h}{Y^1}\right)^{-v} = \left(\frac{Y^1}{Y^h}\right)^{v}$, where household "1" is the poorest household in the dataset. For simplicity the welfare weight for the poorest household, β^1, is set equal to unity. The parameter *k* is a normalization factor, conveniently set equal to 1 as well.

Finally, parameter *v* reflects the researcher's distributional concerns. When $v = 0$ the analyst is indifferent about the distribution of resources but as the value of *v* gets bigger, stronger inequality aversion is built in the analysis[4] and, therefore, the calculation of distributional characteristics gives

[4] In order to clarify: when $v = 0$ the expression for β^h collapses to 1 and the same weight is given to each household, it follows that the analyst is indifferent about the distribution of resources and that the distributional characteristics are simply

higher coefficients for the goods whose consumption is much concentrated among less well-off households.

To sum up, according to the values attached to the parameter *v*, the relative welfare weights associated to each household change and, consequently, the ranking of the goods by distributional characteristics may also differ. Typically, as *v* increases, necessities will get relatively larger values of distributional coefficients (whereas luxuries will get relatively smaller ones) because the consumption by less well-off households receives a relatively bigger weight.

However, since these coefficients depend on the welfare weights β^h that follow directly from the application of a precise function (e.g. the Atkinson utility function), the results will be tied to a particular choice of the researcher. Analysis carried out by distributional characteristics is so somehow arbitrary given that a different function may lead to a diverse ranking of the goods[5].

As anticipated, the stochastic dominance approach allows this problem to be circumvented. Next section illustrates how consumption dominance curves encompass a wide class of social evaluation functions displaying aversion to inequality and symmetry.

2.2 Consumption Dominance Curves.

The exposition mainly follows the papers of Makdissi and Wodon (2002) and Duclos, Makdissi and Araar (2009).

Consider a class of additive indexes of poverty that the government wishes to reduce:

$$P(F,z) \;=\; \int_0^a \mathrm{p}\;(y^E(q,y),z)\;dF\;(y)$$

where F is the distribution of household resources defined over the interval [0, a] and *z* (s.t. $z < a$) is the poverty line defined over the distribution of equivalent expenditure or income , y^E, and q is the vector of current consumption prices[6]. The function $p\;(y^E(q,y),z)$ measures the poverty of a household with monetary resources y^E and adopting a poverty line *z*. It is non-negative for all households and equals to zero for those ones whose y^E is above the poverty threshold *z*. Finally, the poverty measure must be a continuous function *s*-time differentiable over [0, a] with

$$(-1)^i p_1^i(y^E(q,y),z) \;\geq\; 0\,,\forall i \;=\; 1,2,\dots,s$$

equal to 1 for every good. Increasing values of *v* modify this setting in the sense that β^h gets smaller than one for all households (except the poorest one) and lower and lower weights are attached to richer families.

[5] For instance, another social evaluation function commonly used in welfare and inequality analysis is the rank-dependent utility function that is built in the computation of the Gini Coefficient, the most popular inequality index.

[6] Where equivalent monetary resources y^E is the level of income (or expenditure) which at the reference price vector q^R would have yielded the same level of utility as y under q. Given that V(.) is the indirect utility function y^E can then be implicitly defined as $V\;(q^R,y^E) = V(q,y)$.

where $p_1^s\ (.)$ is the *s-th* derivative of the function *p*(.) with respect to its first argument, y^E.

This class of poverty measures can be denoted by $\prod^S(z)$. For different values of *s*, the poverty indexes will have different properties. In general, increasing values of *s* lead to higher sensitivity of the poverty measure to the changes occurring in the lower part of the distribution.

For poverty indexes $P \in \prod^1(z)$, an increase in income or total expenditure reduces poverty: this class of poverty measure is Paretian and respects the property of anonymity. When *s=2*, the poverty indexes in use are convex and therefore respect the Pigou-Dalton principle of transfer stating that any progressive transfer reduces poverty[7]. In regard to poverty indexes belonging to the class $\prod^3(z)$, they are also transfer sensitive so according to what point of the resource distribution the transfer takes place at, its impact on the poverty measure will be different. Indeed, a progressive transfer that takes place at the bottom of the distribution will result in a bigger poverty reduction than the one taking place just below the poverty line[8].

Suppose the vector of current consumption prices are equal to *q* = *e* + *t*, where *e* is for the vector of producer prices considered to be constant (and set equal to 1 for expositional simplicity), while *t* is the vector of specific tax rates. When we consider a marginal revenue-neutral tax reform modifying the prices of two goods (i.e. commodities *i* and *j*) the effect of these marginal changes will impact the poverty level of an individual or household with monetary resources *y* by

$$dp\ (y^E(q,y),z)\ =\ p_1^1(y^E(q,y),z)\frac{\partial y^E(q,y)}{\partial t_i}dt_i + p_1^1(y^E(q,y),z)\frac{\partial y^E(q,y)}{\partial t_j}dt_j$$

where p^1 is the first derivative with respect to y^E of the function $p(y^E(q,y), z)$.

Since $dq_i = dt_i$, we have $\frac{\partial y^E}{\partial q_i} = \frac{\partial y^E}{\partial t_i}$.

By applying Roy's Identity and setting the vector of reference prices (used for equalizing the monetary resource) to be equal to the vector of prices before the reform, i.e. $y = y^E$ (see Besley and Kanbur (1988) and King (1983)), the change in households' resources y^E due to a marginal change in the tax rate on good *i* is given by the Marshallian demand of good *i* :

$$\frac{\partial y^E}{\partial q_i} = \frac{\partial y^E}{\partial t_i} = -\ x_i(q,y)$$

[7]Where "*progressive*" is the transfer that redistributes wealth from any individual above the poverty line to an individual placed below that threshold and the defined as poor.
[8]Concrete examples of poverty indexes corresponding to the increasing values of s and commonly used in poverty analysis are: the Headcount Ratio, which simply measures the proportion of the population that lives below the poverty line (s=1), the poverty gap indexes, which measure the poverty severity within a country (s=2) and the Foster Greek Thorbecke measure of poverty when it is computed by setting the weighting coefficient equal to 2 (Foster, J et al. (1984)).

Assuming that the government wishes to implement a revenue-neutral indirect tax reform, the overall tax revenue must be kept constant: the marginal tax reduction on a good must be financed by a marginal tax increase on the other one[9].

It implies that

$$dt_j = -\gamma \left(\frac{X_i}{X_j}\right) dt_i \text{ where } \gamma = \frac{1 + \frac{1}{X_i}\sum_{k=1}^{K} t_k \frac{\partial X_k}{\partial q_i}}{1 + \frac{1}{X_j}\sum_{k=1}^{K} t_k \frac{\partial X_k}{\partial q_j}}$$

X_k is aggregate total consumption of the good k and γ represents the differential efficiency cost of raising one dollar of revenue by taxing good j and using the proceeds to subsidise good i.

Substituting this expression for dt_j in the previous equation, Makdissi and Wodon (2002) come to an expression for the marginal individual change in poverty[10]:

$$dp\ (y^E(q,y),z) = -p_1^1\ (y^E(q,y),z)\left[\frac{x_i(y)}{X_i} - \gamma\ \frac{x_j(y)}{X_j}\right] X_i\, dt_i$$

At this stage, the authors define their new analytical tool. The Consumption Dominance Curves of order s =1 are given by $CD_k^1(y) = \frac{x_k(y)}{X_k}$, that is the ratio of the consumption of good k for a household with monetary resources y divided by the aggregate consumption of the good. For the second dominance order, the consumption dominance curves are given by the share of total consumption of good k consumed by families whose expenditure level is less than an agreed threshold of y. In mathematics, it is $CD_k^2(y) = \int_0^y CD_k^1(u)\, d\mathrm{F}(u)$. For order $s \geq 3$ the formula is $CD_k^s(y) = \int_0^y CD_k^{s-1}(u)\, d\mathrm{F}(u)$.

Hence, the change in poverty of an individual can be re-written as:

$$dp\ (y^E(q,y)\ z) = -p_1^1\ (y^E(q,y),z)\left[CD_i^1(y) - \gamma CD_j^1(y)\right] X_i\, dt_i$$

By integrating the above expression over the interval of income distribution that defines who the poor are, we obtain the total change in poverty induced by the reform:

$$\frac{dP(F,z)}{dt_i} = -X_i dt_i \int_0^a p_1^1\ (y^E(q,y),z)\left[CD_i^1(y) - \gamma CD_j^1(y)\right] dF\ (y)$$

[9] If R is the per capita tax revenue of the overall indirect tax system, such that $R(q) = \sum_{k=1}^{K} t_k X_k(q)$, the impact of the marginal tax reform on per capita tax revenue is then given by

$$dR = \left[X_i(q) + \sum_{k=1}^{K} t_k \frac{\partial X_k(q)}{\partial t_i}\right] dt_i + \left[X_j(q) + \sum_{k=1}^{K} t_k \frac{\partial X_k(q)}{\partial t_j}\right] dt_j$$

Revenue neutrality implies that dR = 0.

[10] This expression is similar to the result obtained in the context of poverty alleviation by Besley and Kanbur (1988). Nevertheless, this one is more general because it allows for efficiency issues (through the parameter γ) and encompasses a wider class of poverty indexes.

The main result that Makdissi and Wodon (2002) reach is the proof that if and only if

$$CD_i^s(y) - \gamma\, CD_j^s(y) \geq 0\,, \qquad \forall y \leq z^+$$

a marginal tax reduction on good *i* financed by a marginal increase in the tax on good *j* will lead to a decrease in poverty, $d\text{P}(F,z)dt_i \leq 0$, for all additive poverty indexes P $(z) \in \prod^S(z)$, for all orders of dominance *s* and for all poverty lines $z \in [0, z^+]$ where z^+ indicates the reasonable maximal value of poverty line.

Despite being a powerful conclusion that allows for valuable policy evaluations, it is not exhaustive as not every tax reform is necessarily revenue-neutral.

A recent study fills this gap. Duclos, Makdissi and Araar (2009) focus on testing whether an indirect tax reform can be labelled as "*pro poor"* by considering its distributional effects also in other scenarios than revenue-neutrality such as single price changes[11].

To this purpose the expressions for relatively and absolutely *pro poor* consumption dominance curves $CD^{\eta:s}$, with $\eta \in \{R, A\}$ and $s \in \{1,2,3...\}$) are derived[12]:

$$CD_i^{R:s}(y) \;=\; \begin{cases} \left[\dfrac{x_i(q,y)}{X_i(q)} - \dfrac{y}{\mu}\right] f(y)\,, & if\ s = 1 \\ \displaystyle\int_0^z CD_i^{R:\,s-1}(y)dy, & if\ s \geq 2 \end{cases}$$

and

$$CD_i^{A:s}(y) \;=\; \begin{cases} \left[\dfrac{x_i(q,y)}{X_i(q)} - 1\right] f(y)\,, & if\ s = 1 \\ \displaystyle\int_0^z CD_i^{A:\,s-1}(y)dy, & if\ s \geq 2 \end{cases}$$

where μ is average income (or total expenditure) and *s* is the order of dominance.

After obtaining these expressions, Duclos, Makdissi and Araar (2009) prove that the necessary and sufficient condition so that a marginal decrease in the tax on good *i* is (relatively or absolutely) *pro-poor* for all poverty indices $P(z) \epsilon\, \Pi^S(\text{z})$ and poverty lines $y \in [0, z^+]$, is:

$$CD_i^{\eta:s}\;(y) \geq 0\,, \qquad \forall\, y\, \in [0, z^+]$$

The authors also explain how the final distributional outcome of a single-good tax change is strictly related to whether the commodity is an inferior, a necessary or a luxury good.

[11]For instance, the government wishes to implement a marginal reduction (increase) in the tax on good i, without offsetting the fall (increase) in total government revenue.

[12]The superscripts "*R*" and "*A*" are respectively for relative and absolute *pro-poorness*. As already anticipated, a tax reform is named to be *pro poor* if the benefits of the change accrue more to the poor (or its costs hurt less the poor) in absolute or relative terms. However the two analytical definitions of *pro poorness* can be found in Duclos, Makdissi and Araar (2009) pp. 8-9.

In particular, regardless the order of dominance and the maximal value of poverty line considered, a reduction (an increase) in the tax of good *i* is never (always) absolutely *pro-poor* if *i* is a normal good. On the other hand, a decrease in the price of *i* is always absolutely *pro-poor* if *i* is an inferior good. Similarly, monetary resources elasticity of the good plays a role also in defining the relative *pro poorness* of single price changes: a reduction (an increase) in the tax of good *i* is never (always) *R-pro poor* if *i* is a luxury good, whereas it is always *R-pro poor* if the good is a necessity.

However, commodity income elasticity may vary across households' monetary resource distribution, therefore, in order to test *pro* (*anti*) *poorness* of any tax change, the researcher ought to check whether condition ${CD_i}^{\eta:s}\ (y) \geq 0$ holds or not over the range of poverty lines.

2.2.1 Some additional remarks.

Before turning to the presentation of the data, another crucial point for the assessment of the social impact of tax reforms needs some attention: the distortionary effect due to taxation.

From above, we know that the necessary and sufficient condition for a revenue neutral tax reform to be poverty reducing (for all indexes P(*z*) ∈ $\Pi^s(z)$, all orders of dominance *s* and all poverty lines $y \in [0, z^+]$) is that the consumption dominance curves of the goods involved in the reform are not intersecting over the range of plausible poverty lines. In maths:

$$CD_i^s(y) - \gamma\, CD_j^s(y) \geq 0\,, \qquad \forall y\ \in [0, z^+]$$

where indeed γ is an efficiency parameter that accounts for the relative deadweight losses following the change in prices of goods *i* and *j* (Makdissi and Wodon (2002)) and it is computed by dividing the distortionary effect due to a tax increase on good *j* by the same effect due to a drop in the price of good *i* [13]. It follows that whether compensated price elasticities are the same across all goods involved in the reform (i.e. the two distortionary effects compensate each other) the parameter γ is equal to one and the reform is "efficiency neutral". On the other hand, when the deadweight loss from taxing *j* is bigger than the distortionary effect due to subsidizing good *i* (i.e. γ is greater than one), the reform implies an efficiency loss in the economy and any welfare improvement is compromised.

However, despite being economically inefficient, a tax reform can still be "poverty efficient" if the additional burden due to the efficiency loss is supported only by the non-poor. Finally, when parameter γ is smaller than one, the reform is economically efficient and its implementation leads to an improvement in the social welfare.

[13] The formula for computing the differential efficiency cost of the reform is $\gamma = \frac{1+\frac{1}{X_i}\sum_{k=1}^{K} t_k \frac{\partial X_k}{\partial q_i}}{1+\frac{1}{X_j}\sum_{k=1}^{K} t_k \frac{\partial X_k}{\partial q_j}}$.

It results that the estimation of the efficiency parameter is crucially important for the researcher who intends to evaluate the social impact of a revenue neutral tax reform. However, since γ accounts for own and cross price elasticities of the goods (or good aggregates) involved in the reform, its correct computation is so much data demanding that a working assumption is often adopted and it is set equal to one. Thus, a revenue neutral reform is assumed to be also efficiency neutral.

By looking at the formulas it is clear that when $\gamma = 1$, the tests for absolute and relative *pro-poorness* become equivalent[14] and, consequently, an efficiency and revenue neutral tax reform is absolutely and relatively *pro poor* if the poor's share of total consumption of good *i* exceeds their share of the total consumption of good *j* (Duclos, Makdissi and Araar (2009)). Conversely, when a reform is not efficiency neutral ($\gamma \neq 1$), the interpretation of relative and absolute *pro poorness* differs; the respective *pro poorness* tests must be performed separately and may deliver different results.

Precisely, when a reform is economically inefficient (i.e. $\gamma > 1$), the deadweight loss in the economy leads to a fall in overall welfare that is recorded as a decrease in general expenditure. In this case, relative *pro poorness* requires that the fraction of total expenditure by poor households is not reducing after the reform, while absolute *pro poorness* wants that the poor's overall amount of expenditure does not fall after the reform by more than the absolute fall in total expenditure. It follows that an economically inefficient tax reform is more likely to be absolutely *pro poor* than relatively *pro poor*. On the other hand, when a marginal tax reform is economically efficient and so welfare improving (i.e. $\gamma < 1$), a revenue neutral tax change is more likely to be relatively than absolutely *pro poor* [15].

After this methodological framework, we turn the attention to the data. Next section provides a short description of the data in use and some summary statistics.

3. THE DATA.

3.1 Data source and variables of interest.

The main data source for this study is the Italian Household Budget Survey (*Indagine sui consumi delle famiglie italiane*) – henceforth HBS. It is a nationally representative survey conducted every year by the Italian National Institute of Statistics (ISTAT) collecting a variety of information over an independently drawn sample of about 24 thousand households. The aim of this survey is to record households' monthly expenditures on purchasing goods and services designed for final consumption.

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[14]Indeed, for the first order of dominance we have $CD_i^R(y) = \left[\frac{x_i}{X_i} - \frac{y}{\mu}\right]$ (for relative *pro poorness*) and $CD_i^A(y) = \left[\frac{x_i}{X_i} - 1\right]$ (for absolute *pro poorness*). In evaluating distributional impacts of tax reforms we must check if $CD_i(y) - \gamma CD_j(y) \geq 0$, then the expression for both absolute and relative *pro poorness* becomes $\frac{x_i}{X_i} - \frac{x_j}{X_j} \geq 0, \ \forall y \in [0, z^+]$.

[15] Absolute *pro poorness* demands indeed that after the reform the amount of total expenditure spent by the poor increases by more than average total expenditure whereas relative *pro poorness* requires that poor households' share of expenditure simply increases, no matter how much.

Current expenditures are classified in about 200 elementary goods and services, grouped as "foodstuffs", "housing", "tobacco", "furniture, durable goods and house services", "clothing and footwear", "health", "transport", "communication", "fuel and energy", "arts, leisure and games", "education" and "other goods and services".

This study uses three distinct HBS datasets (relative to 2002, 2006 and 2010). The variables of interest have been selected and aggregated in each dataset: namely households' total expenditure and the expenditure for the five good categories that are here the focus of the analysis (i.e. tobacco, alcohol, carbonated drinks, healthy and unhealthy food).

The measure of households' total resources has been created by adding up all the expenditure items in the survey codebook but the house mortgage and loan repayment expenses[16].

While tobacco and carbonated drink expenditures are already two distinct items in each dataset, the expenditure for the other three categories have been computed by adding up expenses for different goods. In particular, alcohol expenditure includes the purchase of wine, beer and liqueurs for in-house consumption[17]. About "healthy food", we have added up the expenses for purchasing fresh and frozen vegetables, legumes and fruit (overall, 13 codebook items are put together).

Similarly, the variable "unhealthy food expenditure" aggregates 10 distinct items. In order to choose the goods that are harmful to the consumer's health, we refer to Marshall (2000) where the foods responsible for the assimilation of about 44 per cent of saturated fat in the UK dietary patterns are listed. These are: whole milk, cheese, butter, biscuits, buns, cakes, pastries, puddings and ice-cream. In the Italian HBS, the categories closest to these are: biscuits, ice-cream, sweet and pastry, butter, oil, lard and other fats, cheese, other dairy products.

To minimise the potential influence of measurement error, we trimmed the data of the extreme values by dropping the top and bottom 3 percentiles of the total expenditure distribution[18].

Finally, in order to account for the economies of scale existing within the household and make families with different demographic profiles comparable, expenditures have been deflated by the square root scale of equivalence[19]. At this point, each household's total expenditure has also been reweighted by the number of members living in it so that our total expenditure distributions are

[16]Whether expenses for house mortgage or other loan repayment (expenses that can be interpreted as investment and not necessarily as consumption) are to be included or not in total expenditure variable, it is often matter of discussion in the literature. However, as HBS reports these expenditure/investment items and the sensitivity of our results to their inclusion/exclusion can be checked, we performed the analysis with two definitions of total household: with and without house mortgage and loan repayment. Since the inclusion of these "investment" expenses does not lead to any significantly different result, along the paper we will report the values referred to total expenditure without mortgage and loan repayment.

[17] Consumption of alcoholic drinks at bars or restaurants cannot be included because HBS data are not detailed enough to distinguish what goods are consumed outside home, consequently the corresponding expenditure cannot be computed. The same applies to spending on carbonated drinks.

[18] This step entailed a drop in the observations in the datasets (precisely 1470 in 2010, 1498 in 2006 and 1769 in 2002), however, given the survey size, this loss of information does not compromise the accuracy of the study.

[19] Accordingly to it, total expenditure is divided by the root square of the number of family members.

consistent with individualistic welfare functions. In this way, indeed, family members are not only thought to pool monetary resources, but also equal weight is given to each person's resources (i.e. individual welfare) regardless if they live by themselves or are part of a large family. Substantially, we assume that resources are equally shared among the family members (children and adults)[20].

3.2 Summary statistics.

Some general summary statistics for 2002, 2006 and 2010 is given in Table 1[21]. Average and median total expenditure are respectively about 1,550 euros and 1,400 euros per month in 2010.

By comparing 2010 with the previous years' values of total expenditure it is clear that during the second half of the past decade there was a remarkable drop in households' consumption: in 2006 mean and median expenditure adjusted for inflation was respectively 1,631 and 1,460 euros per month. On the other hand, expenditure values referred to 2002 show that the trend was reversed in the early 2000s and that a slow increase in consumption expenditure was present at that time[22].

Table 1 also reports the purchasing expenses and budget shares for each good category analyzed here. Generally speaking, the fraction of resources spent on the commodities under observation is quite constant over time. Expenses for tobacco, alcohol and carbonated drinks represent small shares of the total household are expenditure (e.g. tobacco seizes slightly over 1%, alcohol about 0.83% and carbonated drinks around 0.22%), whereas healthy and unhealthy foods seize bigger amounts of families' monthly spending.

Monetary resources spent on unhealthy food are gradually increasing in the recent years, while on the contrary consumption of healthy food represents a decreasing share of the households' overall budget. Since the share of resources spent on general foodstuffs registers a stable 24% of the overall budget over the period considered, if inflation has been consistent over all food products, this figure would suggest that Italian households' consumption patterns are slowly changing towards more unhealthy diet habits. This aspect will be deepened hereinafter.

Italy is characterized by deep geographical differences in terms of income distribution, welfare and employment opportunities, therefore consumption paths may significantly differ according to households' area of residence. At national level, indeed, the budget share spent on foodstuffs on average measures around 24% of families' total expenditure across 2002, 2006 and 2010, but by breaking this figure down by location, we see that households living in the south of the country spend on average 30% of their total expenditure to buy food and drinks, whereas families living in the north

[20] The importance of the choice of appropriate weights in investigating the anatomy of the monetary resource distribution in a country is well highlighted by Danziger and Taussig (1979).

[21] Total expenditure values have been adjusted by using *"Indice dei prezzi al consumo per famiglie operai e impiegati"* elaborated by ISTAT (2010 base year).

[22] This drop in consumption expenditure is in line with the concurrent macroeconomic trend. Specifically, data on national accounts (source: ISTAT), report that in the aftermath of the international economic crisis Italian GDP experienced negative growth rates, respectively of -1,2% in 2008 and -5,2% in 2009.

spend 20% of their budget on the same items. This ten-percentage point difference shows an increasing trend over the past decade and confirms the south to be much poorer than the north of Italy, given that south-based families tend to spend a bigger amount of resources on necessities than families living in the North.

Table 2 is built to account for these geographical gaps and presents some summary statistics for 2010 and 2002 broke down by location. The Italian territory is split in four macro-areas: North West; North East; Centre; South and the Islands. As expected, equivalent total expenditure assumes the highest values in the north of the country and the lowest in the south. In the centre of Italy, average total expenditure is still above the national mean. With regard to commodity budget shares, households living in the south of Italy tend to spend more on tobacco than on average: tobacco budget share is indeed above the national mean (around 1% of the total budget) in both years. About alcohol expenditure the situation is as good as reversed with the highest budget shares recently recorded in the northern regions. Carbonated drinks present low budget shares across the whole country, but the biggest values are registered in the south.

As anticipated, expenditure for essential foodstuffs, both healthy and unhealthy foods, registers the highest budget shares in the southern regions (in 2010 a household living in the south of Italy on average spent on vegetable and fruit almost 4% of its total budget while its spending on unhealthy food seized about 8.23%).

Finally, also in table 2 it emerges a decline in healthy food expenditure versus an increase in the purchase of unhealthy food: in 2002 fruit and veg budget share are always bigger than in 2010 while the reverse holds about sweet, pastry and cheese expenses. In 2010 fatty food budget shares seize a significant amount of households' total expenditure also in the wealthy north (i.e. 5.37% in the North West and 4.78% in the North East).

3.3 Italian households' consumption patterns of *sin goods*.

In order to gain some preliminary insights into what distributional effects would follow from the implementation of an indirect tax reform involving *sin goods* (considering consumers' consumption habits to be stable to price changes), we investigate how the expenditure on each good varies across households' total resources by parametric and non-parametric estimation of Engel curves.

In general, we regress the budget share of the good against the log of total expenditure, according to the Engel curve specification suggested by Working and Leser (W-L henceforth)[23]. At the same time,

[23] In 1943 Working proposed the linear budget share specification of the Engel curve [$w_i = a_i + b_i \log(y)$, where w_i is the fraction of y that is spent buying good i]. However, this specification is known as Working-Leser model, since Leser (1963) found that this functional form fit better than some alternatives. According whether the coefficient on the log of total resources is positive or negative, the good is labeled as luxury or necessity, respectively. If the coefficient b_i is zero (i.e. the Engel curve is flat) it implies that the budget share allocated to the good is independent of resources. A limit of the W-L specification is its inability to identify inferior goods.

the actual form of the relationship between budget shares and total expenditure is non parametrically investigated. Depending on the output delivered by the kernel regression, the functional form of the parametric Engel curves has been adjusted. Finally, to control for the existence of geographical differences in consumption patterns across the country, regional dummies are also included.

Engel curves are estimated for each commodity category under observation and for each dataset so that any relevant change in consumption habits over time would be caught. For the sake of brevity, only the main results are reported here.

Non-parametric regressions for alcohol and carbonated drinks deliver unequivocal and time-consistent outcomes: the relationship between budget shares and households' total resources follows a clear quadratic trend. Figure 1 shows the path of Engel curves for both goods in 2006. Hence, the results of the parametric regression: the coefficients in correspondence of the log of total expenditure and its square are always highly significant and of opposite sign. This suggests that marginal effects of total expenditure on the budget shares of alcohol and soda drink vary over the observations. Indeed, carbonated and alcoholic drinks behave as luxury goods on the lower part of total expenditure distribution, but after a certain point of the distribution, the relationship between budget shares and households' total expenditure changes direction and both goods start following the typical path of necessity goods.

Although alcoholic and soft drinks follow a similar path, Engel curves for beer, wine and liqueurs show a more lasting upward trend suggesting that alcohol is a luxury good for most households.

The parametric regression of Engel curves for alcoholic drinks always deliver highly significant coefficients for the regional dummies and their magnitude suggests that northern families tend to spend more on wine, beer and liqueurs than anywhere else in Italy. Kernel regressions by macro-area show a uniform quadratic trend in alcohol consumption patterns across the country in 2002 and 2006 whereas in 2010 the Engel curve for the north of Italy depicts an upward trend suggesting that there the spending on alcohol products tends to increase with families' resources disposal.

Households' consumption patterns of carbonated drinks show quadratic trends in each Italian macro region and their budget shares do not appear to be affected by location.

Regarding tobacco, the curvature of the non-parametric Engel curves shows a downward trend in each year as well as in every macro region. Figure 2 gives an example of this downward sloping relationship: as households' total expenditure increases, tobacco budget share strictly decreases. The three datasets equally fit the linear W-L Engel curve and the estimation consistently delivers negative and significant coefficients in correspondence with log of total expenditure. Although the minus sign would suggest to label tobacco as a necessity good, the coefficients are so small in absolute value that their economic significance may be questioned and it seems rather that tobacco budget shares are allocated independently of total expenditure.

Engel curves for healthy food show that households' consumption pattern of fruit and vegetables has a trend very similar to tobacco products. Figure 2 also reports the relationship between healthy food budget shares and families' total expenditure in 2006: the graph is almost linear. The trend is monotonically decreasing for every dataset. W-L coefficients are always negative therefore healthy food behaves as a necessity good. Kernel regression outcomes are consistent by location as well as across time: the highest fraction of resources spent on vegetable and fruit is always recorded in correspondence of the lowest part of total expenditure distribution.

Finally, Figure 3 shows that the relationship between total expenditure and the fraction of resources spent on food rich in saturated fats follows a quadratic trend. However, the comparison of Engel curves for fatty food for 2002, 2006 and 2010 suggests that households' consumption habits have slightly changed over the past decade. In particular, kernel regression for 2010 depicts an underlying increasing trend in the bell-shaped relationship between unhealthy food budget share and total expenditure whereas diagrams for 2002 and 2006 show a clearly diminishing trend[24].

In addition, data show that the parabola vertex is shifting towards the upper part of total expenditure distribution in recent years. This would suggest that oil, sweets, cheese and other fatty foods behave as luxury goods for more Italian families today than it used to be in the past.

No meaningful differences stand out by controlling unhealthy food consumption for households' area of residence. However, regional dummies are always highly significant and consistently show bigger coefficients in correspondence of the centre and south of Italy. Far from being surprising, this result confirms that living in the south has a bigger marginal effect on budget shares spent on fruit and veg as well as on fatty food and it is in line with the summary statistics presented above.

To sum up, the investigation of Italian households' consumption patterns across total expenditure distribution allows for some preliminary remarks about what distributional effects *sin goods* tax reforms would have on the population if substitution effects and behavioral responses were ignored.

Firstly, given that highest budget shares for tobacco are always recorded at the bottom of total expenditure distribution and Engel curves consistently show a downward sloping trend, a tax increase involving tobacco products would mostly hit less well-off households and its impact would be decreasing as the households' disposable resources grow. It also appears that poor families living in the south would bear relatively more the weight of a rise in tobacco price.

The introduction of a soda tax would apparently have a similar effect, but minor in magnitude since Italian households set much smaller budget shares for soft drink purchase than for buying cigarettes and other tobacco products.

[24] The parametric results delivered by W-L specification confirm these contrasting patterns: total expenditure (log of) coefficient is positive for 2010 regression, but negative for 2002. The W-L Engel curve for 2006 dataset delivers a positive coefficient in correspondence of total expenditure but very small in absolute value.

On the other hand, Engel curves for alcoholic drinks depict a clean quadratic trend with turning point at the upper part of the distribution therefore, at a glance, an alcohol tax increase would hit in greater proportion households located at the middle of total expenditure distribution. Furthermore, the results about alcohol consumption patterns by location hint that an additional tax on alcoholic products would apparently weigh more on northern households' pockets. A change in price of healthy food seems to affect more the households placed along the lower part of total expenditure distribution since they spend a bigger fraction of resources on fruit and vegetables than richer families usually do.

Finally, Engel curves for unhealthy food suggest that the introduction of a "fat tax" would have a different impact nowadays in comparison with whether it had been introduced ten years ago. In particular, what emerged so far implies that a price increase involving cheese, pastry and other high-fat content goods would have mostly hit low budget families in 2002 and 2006, whereas nowadays a "fat tax" would be increasingly borne by well off families in the south as well as in the north of Italy.

Beyond these preliminary remarks, distributional effects of *sin taxes* will be properly outlined in the next section where the results delivered by distributional characteristics and consumption dominance curves are presented and discussed.

4. RESULTS.

4.1 Distributional characteristics.

In order to further describe the mapping of Italian households' consumption patterns across expenditure classes and investigate the equity impact of changing commodity taxes, distributional characteristics for tobacco, alcohol, carbonated drinks, healthy and unhealthy food are computed. Also, to catch possible changes in the ranking of the goods according to different levels of the researcher's inequality aversion, distributional characteristics are calculated by setting parameter v equal to 1, 2 and 5. Table 3 collects the results.

Italian households' consumption patterns appear to be quite stable over the past decade as the ranking of the goods is rather consistent across 2002, 2006 and 2010 as well as across different values of v.

The goods whose expenditure is mainly concentrated among less well-off families are tobacco and healthy food. In 2010 and 2006 tobacco is ranked first for any value of v, while in 2002 for increasing level of researcher's inequality aversion the two goods swap their positions. This change in the ranking suggests that in the early 2000s fruit and vegetable consumption was more concentrated amongst households placed at the very bottom of total expenditure distribution than it was tobacco. On the other hand, alcohol is the *sin good* whose expenditure is most concentrated amongst richer families because it is always in the fifth position.

This result suggests that an increase in the price of alcoholic products would be relatively more borne by well-off households. On the contrary, a drop in the price of fruit and veg or cigarettes would be relatively more beneficial to poorer families.

About unhealthy food and carbonated drinks, distributional coefficients locate these goods at mid-ranking, with soft drinks ranked 3rd and fatty food placed at the 4th position in both 2010 and 2006. Nevertheless in 2002 their positions are reversed, suggesting that soda drink consumption is becoming relatively more popular amongst lower-expenditure households over the recent years.

However, as highlighted by Madden (2009), we should bear in mind that some goods analyzed here are actually aggregates of single spending items. While this aggregation makes the computation of distributional coefficients easier, it implies a loss of information that may affect the accuracy of the resulting policy prescriptions. In general, the more sub-categories are added up, the bigger the inaccuracy gets since the distributional characteristic of each sub-category would actually differ and finally bring to a different commodity ranking. Hence, according to the variables in use and how the distributional characteristics are computed, diverse policy recommendations might arise[25].

4.2 Consumption dominance curves and poverty impact of single changes in *sin good* prices.

Consumption dominance curves (henceforth CD-curves) are estimated for each commodity category and plotted against equivalent total expenditure. In order to make the interpretation easier, the measure of households' monetary resources has been normalized and divided by 60% of its median, a value commonly chosen as poverty line in poverty analysis. It follows that a value of 2 on the horizontal axis indicates twice this poverty line. CD-curves are presented for values of total expenditure up to 120% of median total expenditure, so that a reasonably large range of poverty lines is considered.

Graphs for a good often outline a similar pattern over time therefore more than one diagram per commodity will be reported and discussed only if remarkable differences arise across time. Also, the discussion of the results will only focus on relative *pro* (*anti*) *poor* CD-curves. Absolute *pro* (*anti*) *poor* CD-curves will not be illustrated because their results consistently deliver the same output across our three datasets: absolute CD-curve for any good lies below zero for all plausible values of the

[25] For example, let's take the commodity category labelled as "alcohol". It actually includes the consumption of three items whose expenditure is originally separated in the HBS codebook: "wine", "beer" and "spirits and cocktails". Keeping them separated, the same calculation of distributional characteristics provides a different ranking from the one in table 3 as the consumption of alcoholic products differs across households' total expenditure distribution. Indeed, the good whose consumption is mostly concentrated amongst well-off households is "*spirits*" followed by "*wine*" (again two alcoholic products) but "*beer*" is ranked at position 4 or 3 (out of 7 goods). This suggests that an increase in beer price would relatively affect also less well-off families. Thus, a policy recommendation suggesting a general alcohol tax increase would be misleading. If the researcher is mostly concerned about equity, introduction of a tax on alcoholic drinks according to their alcohol content may sound more appropriate.

poverty line indicating that any price rise examined in this context would lead to a bigger loss (in absolute value) for non-poor households than for the poor ones. Thus, any reform involving an increase in tax rates on the analysed goods would be labelled as "*absolutely pro poor*"[26]. Now, we turn to the presentation of the results. Relative *pro* (*anti*) *poor* CD-curves are reported in figures 4-8.

Our evaluation of the distributional impacts of single tax changes starts with tobacco and alcohol, two *sin goods* whose consumption is already explicitly taxed in Italy by the application of specific excises or ad valorem taxes[27].

Figure 4 shows the first order CD-curve for tobacco products in 2010. As the curve is positive for all plausible poverty lines, we can state that further increases in the price of cigarettes and rolling tobacco would proportionally impose a bigger burden to less well-off households than to the non-poor. In this sense, such reform is to be labeled as "*relatively anti-poor"* and would result in an increase of all Paretian and symmetric poverty indexes. This result is clear-cut and consistent across time eliminating the need to check for higher orders of dominance[28].

Figure 5 shows an almost reversed picture about alcohol: CD-curves are negative over considerable intervals of plausible poverty thresholds. Consistent with the findings of Duclos, Makdissi and Araar (2009), this implies that a marginal decrease in alcohol taxes would lead to proportionally greater benefits to well-off households and confirms that a price reduction involving a luxury good can never be relatively *pro poor*[29].

However, by comparing alcohol CD-curves for 2010 and 2002, it is noteworthy that poverty impacts from changing alcohol taxes would have not been the same across time: indeed, first order dominance CD-curve for 2010 is mostly negative whereas the one for 2002 becomes strictly positive from values of total expenditure around 0.9 (i.e. about 54% of the median)[30]. This implies that in 2002 a reform involving a decrease in alcohol taxes could have been interpreted in contrasting ways according to the poverty threshold adopted. Precisely, a decrease in alcohol excises would have been seen as responsible for a relative lightening of the fiscal burden supported by the poor if the analyst had set

[26]This result is somehow trivial. Indeed, it simply follows from the fact that well-off families generally spend bigger amounts of their resources (in absolute value) on purchasing goods than the less well-off usually do. Poor households tend to use higher fraction of their resources to the same purpose so in relative terms the results are often reversed.

[27]Italian law ordains that in addition to 21% VAT, alcohol beverages are subject to excise duties equal to 2.35 euro per hectoliter/°Plato for beer; 800 euro for ethyl alcohol and 68.51 euro per intermediate alcoholic products. Wine is not subject to any special excise. On the other hand, cigarettes are subject both to excises and ad valorem taxes respectively equal to 8.90 euro (per 1000 cigarettes) and 54.26% of the retail selling price. For a complete listing of special excise duties applied to alcohol and tobacco in the European countries, see the website of EU Commission, section "Taxation and Custum Union": http://ec.europa.eu/taxation_customs/taxation/excise_duties/index_en.htm

[28] Tobacco CD-curve in Fig.5 is actually negative for early values of total expenditure distribution (around 0.3 times the reference poverty line). However, such values are clearly too low to be considered a sensible poverty line so the fact that CD-curve is negative there does not compromise the result. Also, since the 1st order dominance refers to Paretian and symmetrical poverty indexes, the effect that a tobacco tax change might have on those very poor households would be completely offset by opposite impacts on just slightly richer families. Hence, we affirm that 1st order dominance is observed and checking for higher orders would be redundant.

[29] As discussed in section 3.3, figure 1 depicts a bell-shaped Engel curve for alcohol products.

[30] Alcohol CD curves for 2006 follows the same trend pattern as the CD curves for 2010 reported in figure 6 (s=1, 2).

the poverty line at 60% of the median total expenditure or higher, while it would have been interpreted as relatively *anti-poor* by a researcher setting a lower poverty threshold (e.g. 40% of the median).

This case well illustrates how valuable the stochastic dominance approach can be in poverty analysis, since it allows for detecting at what point of the monetary resource distribution the poverty outcome of a same policy would be reversed.

Since we cannot observe first order poverty dominance, second order CD curves are included in Figure 5. Also considering a more restricted class of poverty indexes, the results for 2010 and 2006 suggest that a decrease in alcohol price would bring proportionally larger benefits to the well-off than to the poor (i.e. the respective second order CD-curves are strictly negative over the entire range of plausible poverty lines). On the other hand, in 2002 s=2 CD-curve for alcohol lies below zero for values around the main poverty line but it becomes positive at about 1.3 times its value. It follows that for poverty lines bigger than 60% of the median total expenditure, a drop in alcohol price would have been relatively *pro poor* and poverty gap measures would have possibly recorded a reduction in the intensity of poverty in Italy. Nevertheless, such remarks do not hold anymore for the recent years.

Figures 6, 7 and 8 allow for the evaluation of *pro* (*anti*) *poorness* of single price changes involving carbonated drinks, healthy and fatty food. To date, these goods are not subject to special fiscal policies (such as additional specific excises or subsidies) in Italy, but the introduction of specific taxes on food and drinks which, being rich in sugar or saturated fats, are considered harmful to heavy consumers' health, has recently become a topical issue together with the evaluation of their impact on the less well-off.

First order dominance CD-curve for soda drinks is shown in figure 6. The graph is positive in correspondence of all plausible values of poverty lines therefore a VAT increase or the introduction of a new specific excise on frizzy beverages would be relatively *anti poor*. Similarly, a decrease in the price of fruit and veg would relatively benefit more the households placed at the very low part of total expenditure distribution. By the way of example figure 7 shows first order CD-curve for healthy food consumption in 2010. Consistent with the typical path of a necessary good, the graph is strictly positive over the entire range of poverty lines.

Finally, CD-curves for fatty food are presented in figure 8. Different paths emerge across the time period considered: first order dominance graph for 2002 is always positive whereas the recent ones lie below zero for larger and larger ranges of poverty lines. This implies that whether a reduction in the price of pastry, oil, cheese and other dairy products would have reduced all the Paretian and symmetric poverty measures belonging to the class $\prod^1(z)$ in 2002; a similar conclusion does not hold for the second half of 2000s.

Actually, the CD graphs seem to suggest that the outcome would be reversed. CD-curve for 2010 is negative over a considerably large poverty line interval (i.e. dominance is observed until 90% of median total expenditure) so that it appears reasonable to state that a price increase in fatty food would be relatively *pro poor* for most of poverty lines. On the other hand, in 2006 CD-curve is both positive and negative and does not allow for observing neither first or higher orders *pro poorness* dominance. It follows that it is impossible to unambiguously state what impact a price increase involving fatty food would have had in 2006 given that poverty effects change according to the threshold chosen by the analyst.

Despite these contrasting results emerging from the cross time analysis of CD-curves, the outlined consumption trends suggest that the purchase of fatty food is recently becoming less concentrated among households at the bottom of total expenditure distribution. This implies that the introduction of a special tax on fatty food would harm in greater proportion well-off families. Such a reform could be unambiguously labelled as relatively "*pro poor*" nowadays, at least in terms of *poverty gap* measures.

4.3 Consumption dominance curves and poverty impact of revenue neutral tax reforms.

After the evaluation of the *pro-poorness* impact of single price changes, the revenue neutral tax reform scenario is examined. We consider a government which offsets a marginal tax reduction for good *i* by a marginal increase in the tax on good *j* in order to keep overall tax revenue unchanged.

In terms of the presentation of results, instead of plotting the two CD-curves on the same graph and checking for no intersection to test for dominance, the difference between the curves is computed and then plotted against normalised total expenditure. This way of proceeding should makes easier to interpret the findings since the sign of the CD-Difference curve will directly reveal whether a given reform is *pro* or *anti poor*.

Consistent with the analysis of single price changes, the CD-Diff graphs are plotted against a range of poverty lines going from zero to 120% of the median of equivalent total expenditure. CD-Diff curves are estimated for each dataset, but more than one graph per reform will be discussed only if remarkable differences arise over time. Dominance orders higher than one are checked only if the first order dominance does not allow for unambiguous *pro-poorness* statements.

Table 4 shows the consumption dominance curve grids for 2002, 2006 and 2010 and summarises the outcomes of poverty dominance tests for all efficiency and revenue neutral tax-subsidy combinations that are possible with the five commodity categories analysed. Dominance is observed in most cases and confirmed across time. The most controversial results concern the reforms combining fatty food with alcohol products (in 2010 and 2006) and healthy food with tobacco (in

2006 and 2002). Given the similar consumption path of the two goods combined, this result is not surprising.

Despite the large number of possible revenue neutral tax changes arising from the mutual combination of the goods, only three indirect tax reforms will be illustrated here. Precisely, we will focus on the poverty effects deriving from the combination of a subsidy on fruit and vegetables with a soda tax, first, and with a fat tax, after. The third revenue neutral tax reform to be assessed involves a reduction in tobacco duties compensated by an increase in alcohol excises.

It is worth stressing that the form of these fiscal changes is fully arbitrary and that while the first two reforms may find a political background, the reform involving alcohol and tobacco is fairly notional since there is no clear economic rationale for decreasing taxes on tobacco[31].

The impact of an efficiency and revenue neutral tax reform involving healthy food and carbonated drinks for 2010 is shown in Figure 9. The graph is mainly positive. It suggests that a decrease in VAT rate for fruit and vegetables compensated by an increase in taxes on frizzy drinks would be poverty reducing according to all the Paretian and symmetric indexes belonging to class $\Pi^1(z)$ [32]. This outcome is consistent across time.

Although the lack of data prevents from estimating the differential efficiency cost of the reform and mainly limits the analysis to efficiency (and revenue) neutral tax changes, by means of dominance tests performed by varying the parameter γ, we can affirm that a VAT decrease on healthy food compensated by an increase in taxes on carbonated drinks would be relatively *pro poor* for any γ smaller than 1.2 in 2010. The corresponding critical values are 1.5 and 1.3 in 2006 and 2002.

In absolute terms, this reform is *pro-poor* for any γ bigger than 0.85[33]. However, since absolute CD-curves for soda drinks and healthy food are almost parallel, when the reform differential efficiency cost drops below 0.7, dominance is again observed, but the distributional outcome would be reversed and the reform would be absolutely *anti-poor* (i.e. well-off households would receive greater benefits in absolute)[34].

[31] Tobacco is a widely harmful good, however in addition to paternalist and externality reasons, tobacco taxes are economically well accepted also because they are relatively non-distortionary since demand for tobacco is highly inelastic with respect to its price.
Another concern about subsydizing cigarettes stems from the strong complementarities between alcohol and tobacco consumption that are reported by a growing body of recent empirical literature analysing demand systems of these highly addictive goods (see Decker and Schwartz (2000) for the US, Duffy (2003) for the UK, Pierani and Tiezzi (2009) for Italy).

[32] Actually the curve in fig.9 shows a negative peak at values of the poverty line around 0.4 times the threshold commonly adopted. However 24% of the median total expenditure seems too low to be a plausible poverty line therefore the first order poverty dominance is said to be observed anyway.

[33] Across the surveys under observation, the variation in the critical value of γ does not exceed 0.05.

[34] Broadly speaking, two driving forces make the latter situation absolutely beneficial to richer families. Firstly, as they tend to spend more (in absolute terms) on fruit and vegetables, they tend to benefit more of the subsidy on these products, than the less well-off do. On the other hand, if γ gets smaller and smaller (e.g. γ equals to 0.65), the demand for frizzy drinks is also relatively price inelastic. This implies that just a slight increase in taxes on soda drinks is enough to cover the costs of the subsidy on healthy food. Given that the tax increase can be moderate, richer households will end up with receiving more

Similarly, the efficiency neutral combination of a subsidy for healthy food financed by a specific excise on fatty food would bring positive results in terms of poverty reduction. The respective first order CD-Diff curves for 2002, 2006 and 2010 are always positive over any poverty line up to 120% of median total expenditure. Hence, the implementation of this reform would entail all Paretian and symmetric poverty measures to reflect a poverty reduction.

Figure 10 reports the first order CD-Diff curves for healthy and unhealthy food relative to years 2010 and 2002. Both graphs are positive but the curves draw two different trends (consistently with the time variation in consumption patterns of unhealthy food outlined in section 3.3)[35]. Being the reform absolutely and relatively *pro poor* in both years (i.e. γ = 1 and positive CD-Diff curves), it must be the case that the poor's share of healthy food consumption exceeds their share of consumption of pastry, cheese and other high-fat content products. From the graphs it also emerges that the difference between these two shares of good consumption has recently tailed off for the very poor (i.e. the poor have either increased their spending on fatty food or reduced their purchase of fruit and veg or both).

By varying the values of parameter γ, it results that relative poverty dominance would be observed in 2002, 2006 and 2010 when γ is respectively smaller than 1.1, 4 and 4.5. Actually, since the simple CD-curves for unhealthy food in 2006 and 2010 are negative over a wide range of poverty lines (Fig. 8), even when the relative deadweight losses get substantial (e.g. γ is bigger than 5)[36], poverty dominance is still observed over most of plausible poverty lines. About absolute *pro poorness* in 2006 and 2010, dominance is not observed anymore if the relative deadweight loss γ gets smaller than 0.75. On the other hand, in 2002 the reform is absolutely *pro poor* when γ is bigger than 0.9, but absolutely *anti poor* if γ gets smaller than 0.8.

The last hypothesis of revenue and efficiency neutral tax reform here discussed involves a reduction in tobacco taxes offset by an increase in alcohol excise duties. Figure 11 shows the graphical output of poverty dominance analysis for such fiscal change in 2010: the CD-Diff curve is positive for all plausible poverty lines. This result is clear-cut and consistent across the analysed time span. Hence, an efficiency neutral marginal tax reform decreasing tobacco taxes and increasing duties on alcoholic drinks would be poverty reducing for all poverty indexes included in the class $\Pi^1(z)$.

This result could be somehow expected since distributional characteristics and single price change CD-curves have already made clear that alcohol consumption is in general more concentrated among the well-off than amongst the poor. The converse is true for tobacco. Thus, a non-distortionary

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from the subsidy than what they pay because of the new tax. It follows that a similar reform would be absolutely anti poor and the welfare improvement would mainly accrue on the well-off.

[35] In particular, CD-Diff curve for 2002 takes the highest values in correspondence to the lowest total expenditure levels and after it shows a decreasing trend until being close to zero when normalized total expenditure equals two. On the other hand, the diagram for 2010 does not show the same decreasing trend and in correspondence to the highest poverty threshold, the curve is still markedly above zero.

[36] If γ=5, varying unhealthy food price is five times more distortionary than changing healthy food price. It follows that, since demand for unhealthy food is so more price elastic than demand for fruit and vegetable is, a heavy tax increase on fatty food will be needed in order to finance healthy food subsidy. The greater the tax rate needed the bigger the social welfare loss.

revenue neutral tax reform involving such a commodity combination could not be other than beneficial to the less well-off.

However, it is worth highlighting that, despite the clear output delivered by the poverty dominance analysis, the distributional outcome of this reform might be actually reversed if poor and rich households had different incentive to lie about their usual consumption of tobacco and alcohol drinks. Indeed, if the poor tended to understate their alcohol consumption more than well-off households may do, the poverty impact of this alcohol-tobacco tax change may be actually inverted.

It is also arguable that compensated price elasticities are the same across alcoholic products and tobacco and then that a reform involving a reduction in tobacco excises financed by an increase in alcohol taxes may be efficiency neutral[37]. However, poverty dominance tests performed by varying the parameter γ suggest that this tax reform would be still relatively *pro-poor*, when its differential efficiency cost is smaller than 4 in 2002. In 2006 and 2010, the single price change CD-curves for alcohol are mostly negative whereas the ones for tobacco are strictly positive, therefore CD-Diff dominance is observed over most of poverty lines for any values of γ. About absolute *pro poorness,* dominance is observed for any γ larger than 0.85 in 2002 and larger than 0.8 in 2006 and 2010.

5. CONCLUSION

This paper adopts consumption dominance curve technique, first presented by Makdissi and Wodon (2002), to analyse the poverty impact of a range of marginal indirect tax reforms involving *sin goods* in Italy in three distinct years (2002, 2006 and 2010). Thanks to this approach we could identify the direction of marginal tax changes which would reduce poverty for all poverty measures and a wide range of poverty lines.

From the major results it emerges that an increase in the price of three out of five goods under observation (i.e. tobacco, carbonated drinks and fruit and vegetables) would unambiguously hit in greater proportion the poor than the non-poor. Conversely, a rise in prices of alcohol drinks and fatty food would have different distributional impacts across time. In particular, a policy involving an alcohol tax increase might have hurt the poor according to the poverty threshold adopted in 2002, whereas it would have been labelled as relatively *pro poor* in 2006 and 2010. Similarly, from being clearly relatively *anti poor* in 2002 a fat tax would have become relatively *pro poor* in 2010.

Considering *sin tax* changes on a revenue and efficiency neutral basis, poverty dominance analysis allows us to define whether a subsidy-tax combination is poverty reducing (or poverty increasing) in

[37] Selvanathan S., and Selvanathan, E.,A.(2006) shows that in OECD developed countries demands for tobacco and alcoholic drinks are quite price inelastic, but that own price elasticities tend to be bigger in absolute value for alcohol than for tobacco. On the other hand, Aristei and Pieroni (2010) find that alcohol bevarages consumption is quite insensitive to price changes in Italy (estimated own price elasticities are statistically insignificant) whereas tobacco demand is price sensitive (average elasticity is equal to -1.338). They also show that alcohol and tobacco cross price effects are negative, highly significant and close to one in absolute value.

most of the pair-wise combinations that are possible with the five categories of goods analysed here. In particular, we found that a subsidy on healthy food financed by a tax on carbonated drinks, fatty food or alcoholic beverages would be poverty reducing as well as a reduction in tobacco excises combined with a tax increase penalising alcohol, frizzy drink or unhealthy food consumption. Also, decreasing the price of soda drinks would have positive effects on poverty reduction if accompanied by the implementation of a fat tax or an increase in alcohol excises.

As stressed along the paper, the significance of these policy indications can be questioned since the results are tightly related to the adopted working assumption considering any marginal deadweight loss due to changing prices equal across the commodities involved in the reform (i.e. $\gamma = 1$). We acknowledge that this condition is likely untrue and that price elasticity estimates are essential to perform a complete tax reform evaluation. Italian HBS does not include data on prices of the different commodities and we could not estimate and use own and cross-price elasticities of demand to appraise the actual differential efficiency cost of each revenue neutral reform. This aspect is left to future work.

Despite the lack of relative deadweight loss estimations, the distributional impacts of two out of three revenue neutral tax reforms described in details are however definitely clarified. CD-curves for healthy and unhealthy food as well as CD-curves for tobacco and alcoholic drinks are indeed of opposite signs therefore poverty dominance is observed over a wide range of poverty lines, regardless the value of parameter γ.

Overall, consumption dominance curve analysis performed by location delivers the same results of the nationwide evaluation. No remarkable difference emerges about the sign of any CD and CD-Diff curves, so we can affirm that whether a tax change is poverty reducing in Italy, it will have the same beneficial effect also at regional level.

Nevertheless, the direction of the poverty change is the same, but the impact of the reform may differ by location in its extent. Poverty dominance analysis is indeed a valuable tool only for evaluating the direction of the change, but in order to actually measure the distributional impact of a tax reform the researcher must rely on the traditional computation of poverty indexes. Such calculations and the comparison of precise poverty measures for the pre and post-reform scenarios is another aspect that deserves further research in order to clarify to what extend equity concerns over *sin taxes* find a concrete justification within the Italian context.

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APPENDIX

Table 1. Summary Statistics of Households' Current Expenditures (euros per month)

Italy 2010

	Mean	Std. Dev	Median	Min	Max	Budget share
Number of households 20,776						
Total expenditure	1,547.95	753.51	1,397.21	216.61	6.720.67	
Tobacco	14	26.28	0	0	249.11	1.04% st.dev 0.020
Alcohol	13.08	28.77	4.35	0	733.33	0.83% st.dev 0.016
Carbonated drinks	3.26	5.96	0	0	85	0.22% st.dev 0.004
Healthy food	47.32	33.63	40.47	0	409.79	3.34% st.dev 0.021
Unhealthy food	96.49	131.19	54.81	0	4,540.5	6.30% st.dev 0.071

Italy 2006

	Mean	Std. Dev	Median	Min	Max	Budget share
Number of households 22,141						
Total expenditure	1,519.02	743.27	1,359.26	293.35	6,747	
2010 base year	***(1,631.43)***		***(1459.85)***			
Tobacco	13.91	24.79	0	0	250.73	1.02% st dev 0.019
Alcohol	12.52	22.74	5.15	0	670.32	0.81% st dev 0.012
Carbonated drinks	3.39	6.01	0	0	79.04	0.23% st dev 0.004
Healthy food	47.43	32.46	40.92	0	430.56	3.42% st dev 0.021
Unhealthy food	90.05	117.20	55.02	0	1,040.53	6.07% st dev 0.067

Italy 2002

	Mean	Std. Dev	Median	Min	Max	Budget share
Number of households 25,730						
Total expenditure	1,297.7	648.93	1,155.6	186.5	5,941.9	
2010 base year	***(1,514.42)***		***(1,348.59)***			
Tobacco	12.25	19.62	0	0	206.72	1.07% st dev 0.019
Alcohol	10.99	19.05	4.48	0	512.91	0.86% st dev 0.013
Carbonated drinks	3.10	5.60	0	0	80.94	0.25% st dev 0.005
Healthy food	42.65	28.81	36.94	0	404.56	3.65% st dev 0.023
Unhealthy food	45.82	32.57	39.95	0	542.51	3.86% st dev 0.025

Table 2. Households' Expenditure by Geographical Area

	North West		**North East**		**Centre**		**South & Islands**	
	2010	*2002*	*2010*	*2002*	*2010*	*2002*	*2010*	*2002*
Total expenditure								
Mean	1,747	1,476	1,774	1,430	1,609	1,354.4	1,219	1,052
(std dev)	(786)	(677)	(790)	(652)	(724)	(641)	(593)	(546)
Median	1,602	1,349	1,630	1,298	1,471	1,219	1087	908
Min	217	295	352	308	368	247	279	186
Max	6,698	5,941	6,662	5,813	6,340	5,764	6,720	5,856
Tobacco								
Mean	13.1	12.2	11.8	10.2	13.6	12.7	16.6	13
(std dev)	(26.6)	(22.1)	(25.1)	(20.6)	(26.2)	(20.6)	(26.5)	(19.3)
Budget share	0.81%	0.92%	0.73%	0.74%	0.91%	1.01%	1.48%	1.39%
Alcohol								
Mean	17.1	13.1	15.1	10.9	11.8	11.4	9.5	9.1
(std dev)	(40.5)	(22.9)	(34.7)	(21.3)	(19.4)	(18.8)	(15.3)	(13.6)
Budget share	0.96%	0.92%	0.85%	0.76%	0.76%	0.85%	0.76%	0.89%
Carbonated drinks								
Mean	3.7	3.5	3.6	3.4	2.7	2.7	3.1	2.8
(std dev)	(6.7)	(6.2)	(6.6)	(6.2)	(5.1)	(5.0)	(5.4)	(4.9)
Budget share	0.22%	0.25%	0.22%	0.26%	0.18%	0.21%	0.26%	0.29%
Healthy food								
Mean	47.3	44.6	45.2	40	51.6	45.2	45.6	40.9
(std dev)	(33.7)	(30.1)	(34.9)	(29.6)	(35.6)	(30.2)	(31.1)	(25.7)
Budget share	2.94%	3.30%	2.73%	3.02%	3.42%	3.61%	3.95%	4.29%
Unhealthy food								
Mean	94.6	49.6	83.5	45.8	95.8	43.9	105.9	44.1
(std dev)	(138.6)	(35.8)	(113.7)	(33.1)	(132.1)	(32.1)	(133)	(29.5)
Budget share	5.37%	3.65%	4.78%	3.46%	5.81%	3.46%	8.23%	4.48%

Figure 1. Engel curves for carbonated drinks (on the left-hand side) and for alcohol (on the right-hand side). Kernel regression (Italy 2006).

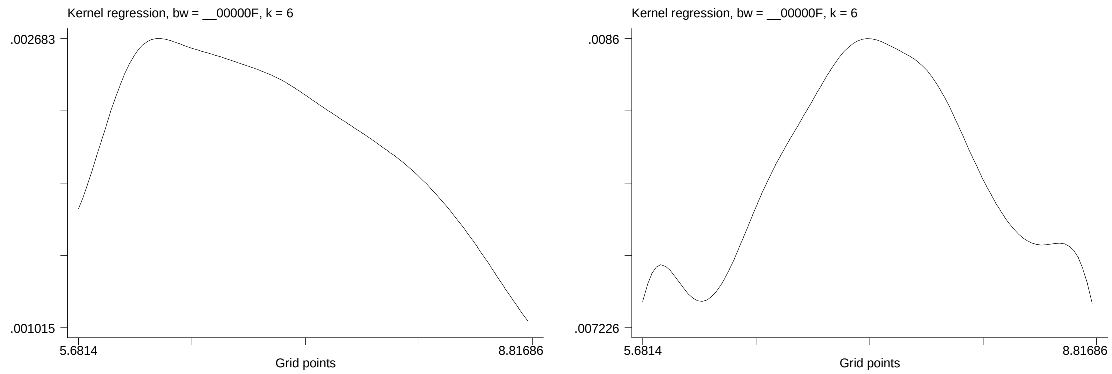


Figure 2. Engel curves for tobacco(on the left-hand side) and for healthy food . Kernel regression (Italy 2006)

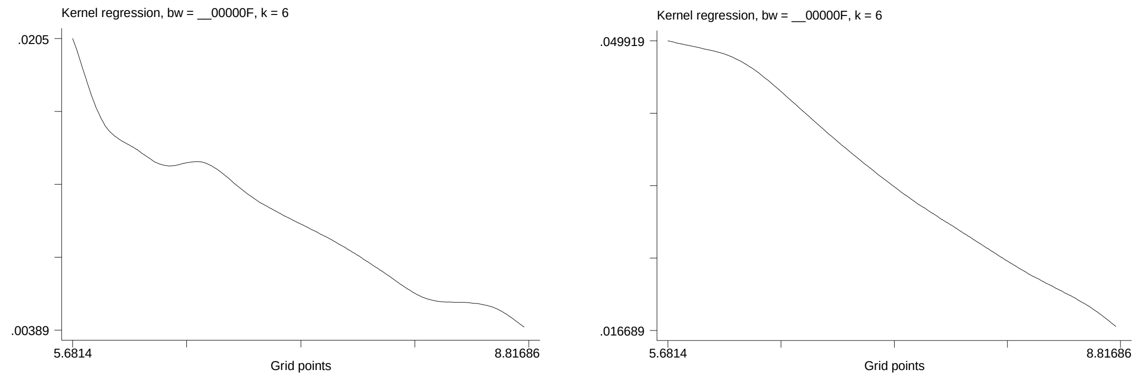


Figure 3. Engel curve for fatty food. Kernel regression (2010)

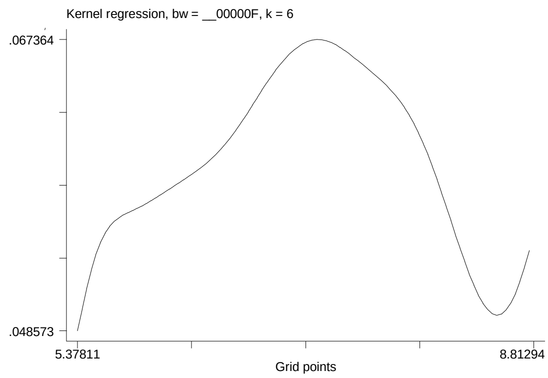


Table 3. Distributional characteristics

Year 2010

Good	*v* = 1		*v* = 2		*v* = 5	
Tobacco	0.16229	**(1)**	0.03270	**(1)**	0.00085	**(1)**
Alcohol	0.14171	**(5)**	0.02477	**(5)**	0.00046	**(5)**
Carbonated Drinks	0.15305	**(3)**	0.02887	**(3)**	0.00062	**(3)**
Healthy Food	0.15604	**(2)**	0.03027	**(2)**	0.00072	**(2)**
Unhealthy Food	0.14396	**(4)**	0.02552	**(4)**	0.00050	**(4)**

Year 2006

Good	*v* = 1		*v* = 2		*v* = 5	
Tobacco	0.21993	**(1)**	0.05979	**(1)**	0.00388	**(1)**
Alcohol	0.19569	**(5)**	0.04735	**(5)**	0.00225	**(5)**
Carbonated Drinks	0.20723	**(3)**	0.05290	**(3)**	0.00266	**(3)**
Healthy Food	0.21533	**(2)**	0.05779	**(2)**	0.00360	**(2)**
Unhealthy Food	0.19959	**(4)**	0.04901	**(4)**	0.00243	**(4)**

Year 2002

Good	*v* = 1		*v* = 2		*v* = 5	
Tobacco	0.16375	**(1)**	0.03340	**(2)**	0.00096	**(2)**
Alcohol	0.14960	**(5)**	0.02769	**(5)**	0.00057	**(5)**
Carbonated Drinks	0.15769	**(4)**	0.03077	**(4)**	0.00072	**(4)**
Healthy Food	0.16190	**(2)**	0.03292	**(1)**	0.00103	**(1)**
Unhealthy Food	0.15946	**(3)**	0.03162	**(3)**	0.00083	**(3)**

Figure 4. Relative *pro* (*anti*) *poor* CD curve for tobacco (s=1 and year 2010)

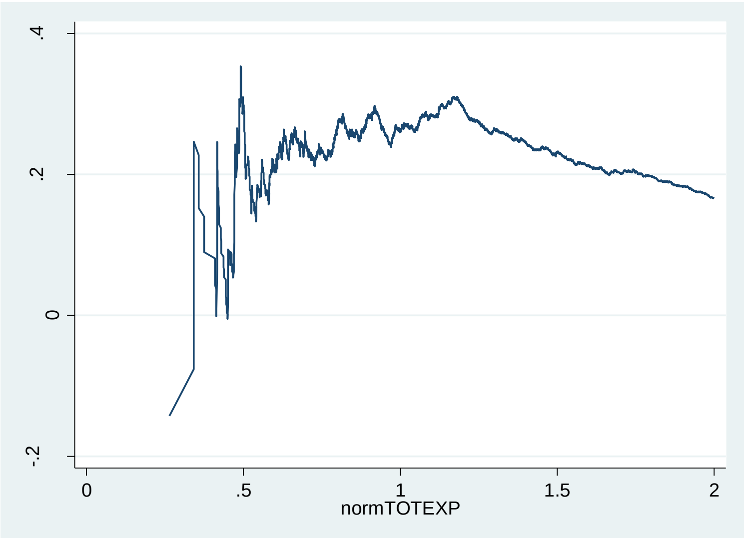
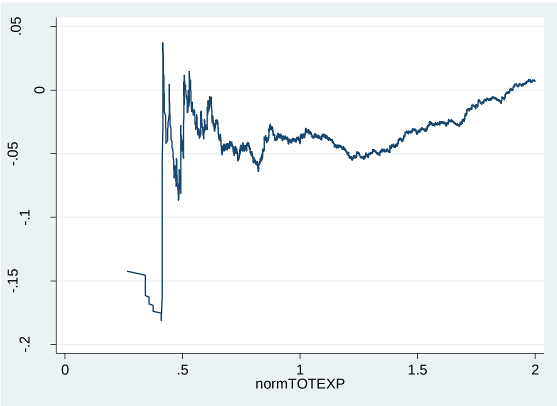
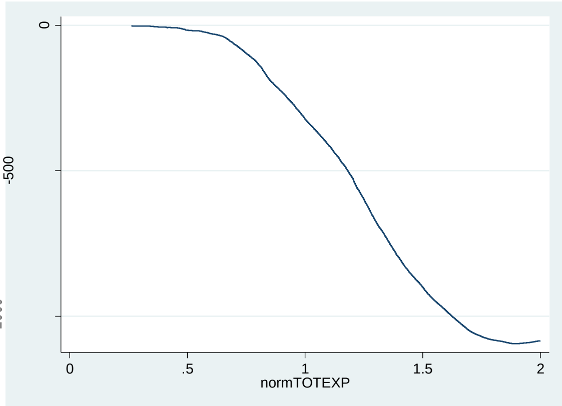


Figure 5. Relative *pro* (*anti*) *poor* CD curves for alcohol
(s=1,2 and years 2010 and 2002)

Year 2010

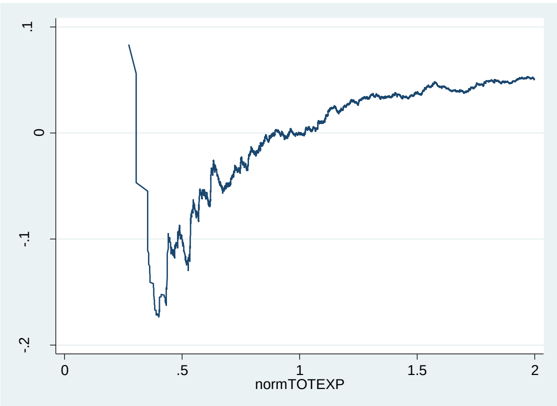


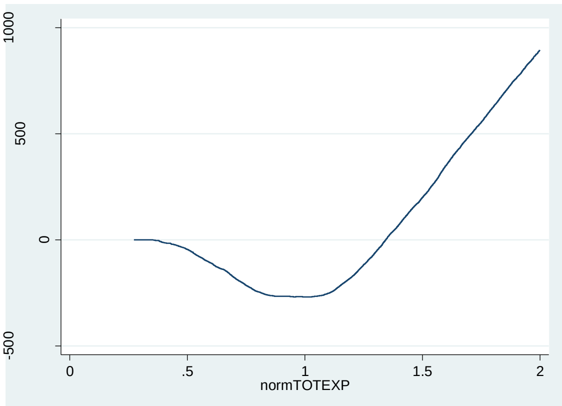


First order of dominance

Second order of dominance

Year 2002





First order of dominance

Second order of dominance

Figure 6. Relative *pro* (*anti*) *poor* CD curve for carbonated drinks (s=1 and year 2010)

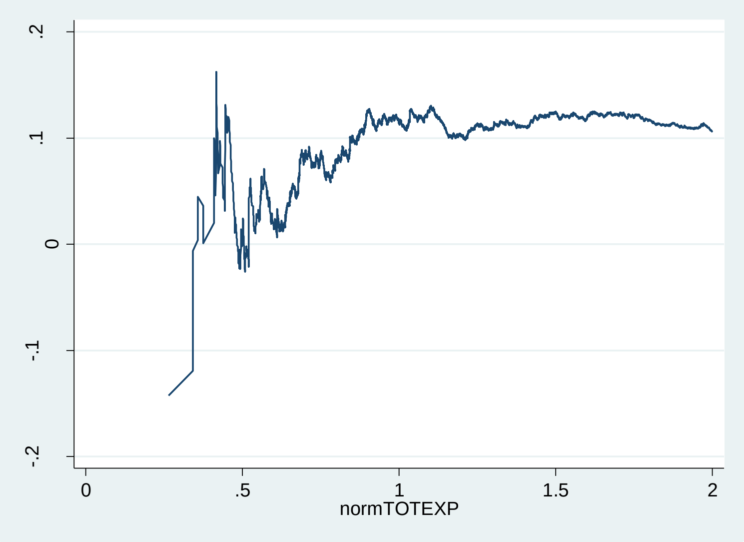


Figure 7. Relative *pro* (*anti*) *poor* CD curve for healthy food (s=1 and year 2010)

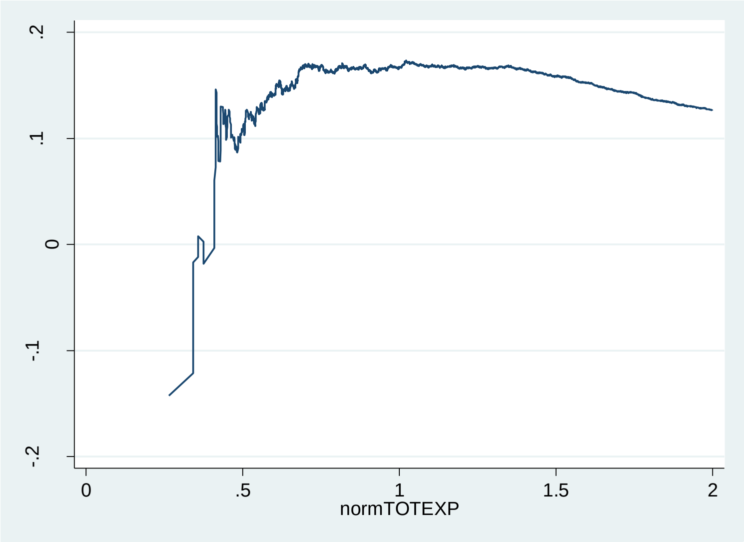
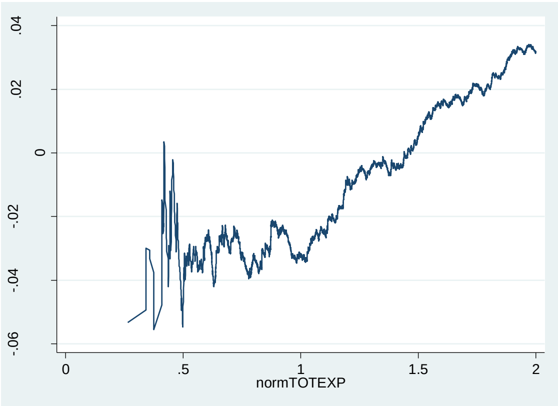


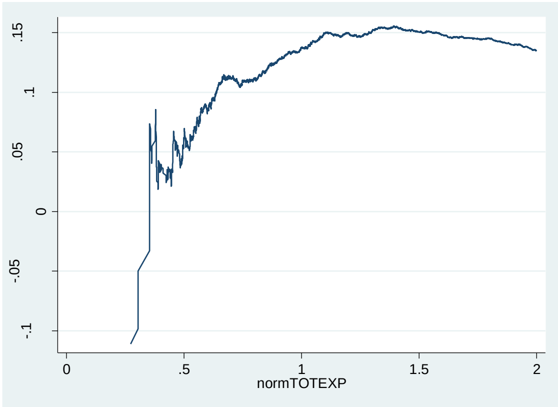
Figure 8. Relative *pro* (*anti*) *poor* CD curves for unhealthy food
(s = 1 in years 2010 and 2002; s = 1, 2 in year 2006)

Year 2010



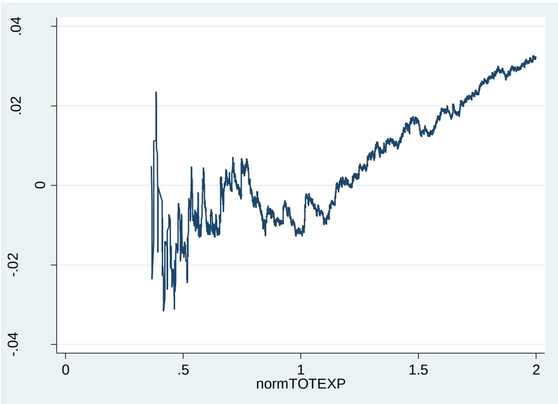
First order of dominance

Year 2002

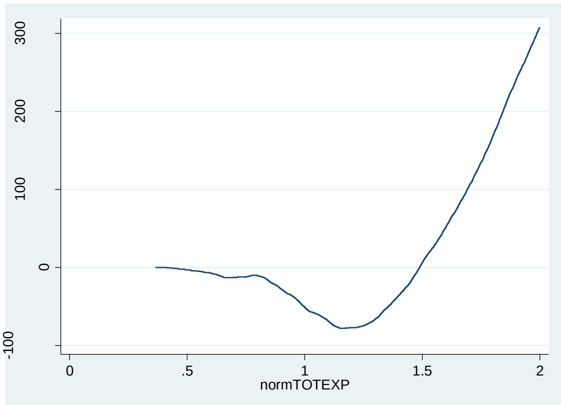


First order of dominance

Year 2006



First order of dominance



Second order of dominance

Table 4. Revenue and Efficiency Neutral Tax Reforms where Dominance is observed *
($\boldsymbol{\gamma}$ **= 1** and s =1)

Year 2010

Tob	~				
Alc	✓	~			
Soda	✓	✓	~		
Veg	✓	✓	✓	~	
Fat	✓	×	✓	✓	~
	Tob	**Alc**	**Soda**	**Veg**	**Fat**

Year 2006

Tob	~				
Alc	✓	~			
Soda	✓	✓(b)	~		
Veg	×	✓	✓	~	
Fat	✓	✓(a)	✓(b)	✓	~
	Tob	**Alc**	**Soda**	**Veg**	**Fat**

Year 2002

Tob	~				
Alc	✓	~			
Soda	✓	✓	~		
Veg	×	✓	✓	~	
Fat	✓	✓	✓(a)	✓	~
	Tob	**Alc**	**Soda**	**Veg**	**Fat**

(a**)** CD-Diff curve is really close to zero.
(b**)** Dominance observed **only for** poverty lines bigger than 45% of the median total expenditure

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* Let's suppose that the column goods are taxed in order to subsidize the row goods. The tick sign indicates that poverty dominance is observed for the corresponding commodity tax-subsidy combination.
Although the possible good combinations are actually twenty, we only report the results for the ten boxes below the main diagonal. However, the upper boxes would be the mirror image of the lower ones because by switching the order of goods in the tax-subsidy combination, the dominance would be equally observed. The sign of the CD-Diff curve in that case would be opposite and then the poverty outcome of the reform reversed
(e.g. if taxing soda drinks in order to lower taxes on tobacco is poverty reducing, taxing tobacco to subsidize carbonated drinks will have the opposite poverty impact).

Figure 9. CD-Diff curve for healthy food and frizzy drinks (s=1). Year 2010.

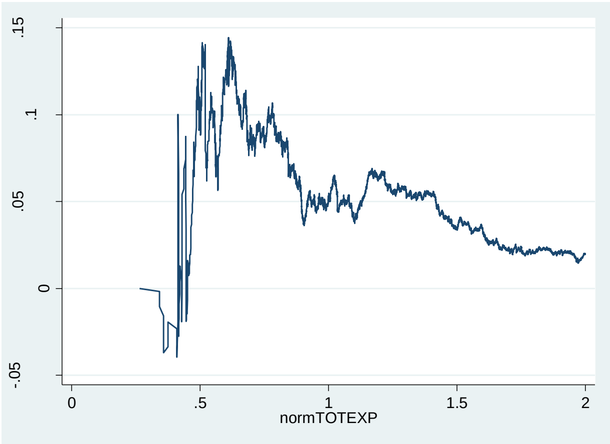

Figure 10. CD-Diff curves for healthy food and fatty food (s=1)

Year 2010

Year 2002

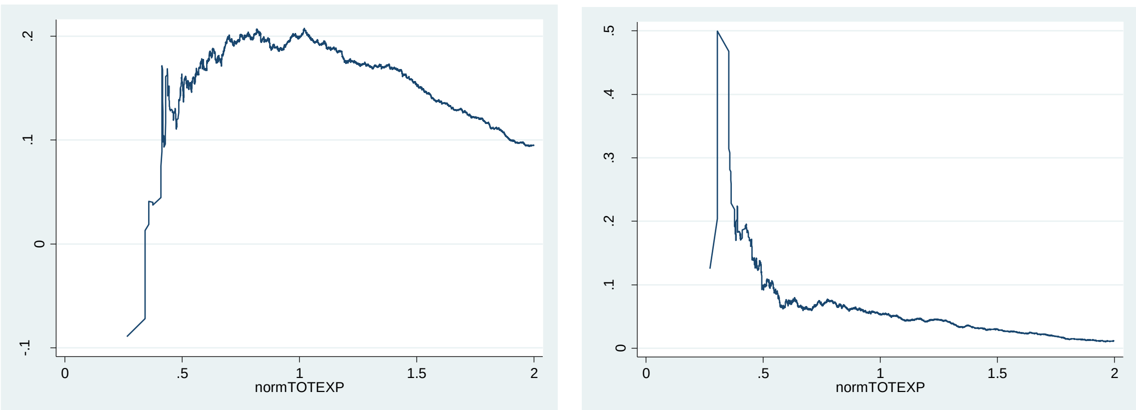

Figure 11. CD-Diff curve for tobacco and alcohol products (s=1). Year 2010.