ELSEVIER European Economic Review 41 (1997) 599–608

EUROPEAN ECONOMIC REVIEW

Microsimulation Models and the Analysis of Tax Policy Issues

Is redistribution through indirect taxes equitable?

André Decoster [a,b,*], Erik Schokkaert [b], Guy Van Camp [b]

[a] *Katholieke Universiteit Leuven, Campus Kortrijk, Kortrijk, Belgium*
[b] *Centrum voor Economische Studiën, Katholieke Universiteit, Naamsestraat 69, B-3000 Leuven, Belgium*

Abstract

A move towards a non-uniform indirect tax structure may result in some vertical redistribution. It will also lead to a different treatment of households with the same total expenditures but with different preferences. To evaluate the social desirability of such rate differentiation we introduce a distinction between needs (for which individuals are not responsible) and tastes (for which they are). We show some empirical results for Belgium, obtained with the microsimulation program *ASTER*. In these calculations we compare the actual Belgian system of indirect taxes with a simpler structure with only two rates. © 1997 Elsevier Science B.V.

JEL classification: C81; C88; D12; D63; H22

Keywords: Microsimulation models; Indirect taxes; Vertical redistribution; Horizontal inequality

1. Introduction

We use a microsimulation model for indirect taxes to analyse the effect of various household characteristics on the redistributive potential of a differentiated indirect tax structure. Our starting point is illustrated by Table 1. This table gives a first insight into the variation of tax rates produced by the actual Belgian indirect tax structure, which is rather differentiated and includes VAT, excises and ad

* Corresponding author. Centrum voor Economische Studiën, B-3000 Leuven, Belgium. Tel.: (+32) 16-326823; fax: (+32) 16-326796.

PII S0014-2921(97)00007-X

Table 1
Variation of tax rates (in % of expenditures)

	Mean	Minimum	Maximum	Coefficient of variation
All households	11.30	4.61	23.61	22.98
Decile 1	11.71	4.61	23.61	27.70
Decile 5	11.54	5.65	19.31	21.76
Decile 10	10.86	5.10	17.12	22.23

valorem taxes. [1] The first line of Table 1 shows that this differentiated system leads to substantial variation in the indirect taxes paid by the different households. However, since the variation in tax liabilities remains substantial within the different deciles, the global variation seems to have little to do with the differences in welfare levels, i.e., with vertical redistribution. Is this equitable?

At first sight, the variation within deciles might seem to indicate a violation of horizontal neutrality. However, this normative statement raises some difficult questions. Consider two households A and B at the same welfare level, i.e., the same level of total equivalised expenditures, but with different preferences and hence different consumption patterns. With a differentiated rate structure, they will pay different amounts of indirect taxes. Let us now compare two situations. In the first situation household A's consumption bundle contains more commodities with a higher tax rate because some of the family members are ill. In the second situation there is no clear difference in the needs of A and B and the differences in consumption patterns reflect merely differences in subjective tastes. Many will feel that the first situation is an example of inequitable discrimination, while the second one is much less of a problem because people can be held responsible for the consequences of their own subjective tastes. This distinction between 'needs' and 'tastes' is discussed extensively in the recent social choice literature and seems particularly relevant in our context. [2]

In Section 2 we propose a simple framework to model the redistributive effect of indirect taxes and to disentangle the needs- and tastes-components. The main idea is the division of the population into mutually exclusive groups, which are homogeneous with respect to needs. [3] We then decompose the vertical redistribution into a redistribution *between* the different needs groups and *within* each group. Empirical results of this decomposition are provided for two indirect tax

[1] Tax rates have been calculated as the indirect taxes paid as a proportion of total expenditures. The tax liabilities have been calculated with the microsimulation model *ASTER*, which is described in more detail in Decoster (1995).

[2] See Fleurbaey (1995) for a short overview and a list of interesting references.

[3] Our approach is in line with the methodology proposed in Kakwani and Lambert (1995) for the measurement of horizontal inequities in the direct tax system. For an alternative framework, see Decoster et al. (1997).

systems. The first is the actual Belgian system, the second is a two-rate system yielding the same tax revenue. The necessary information was generated with the microsimulation program *ASTER*. In Section 3 we separate out the taste factor from the redistribution within the groups. Section 4 concludes.

2. Variation in indirect tax liabilities: Needs and tastes

Let us write T_i, the taxes paid by household i ($i = 1,\dots,N$), as the product of the vector of tax rates t and i's consumption bundle q_i, where the latter depends on the level of total expenditures and on a vector of preference variables π_i:

$$T_i = t'q_i(x_i, \pi_i) = \tau(x_i, \pi_i; t). \tag{1}$$

For simplicity we will omit the vector t from the list of arguments of the indirect tax function, but it is obvious that different tax systems will lead to different τ-functions. The welfare measure for household i is *equivalised expenditures net of indirect taxes*, denoted by y_i. Expenditures net of indirect taxes can be interpreted as a measure of quantities consumed because tax liabilities are calculated under the assumption of fixed producer prices (see also Yitzhaki, 1994). We use equivalence scales to translate expenditures into a welfare-concept. Denoting the scale for household i by η_i, we thus define the welfare of household i after taxation as

$$y_i = \frac{x_i - T_i}{\eta_i}. \tag{2}$$

Equivalised expenditures before taxes are denoted by $\tilde{x}_i$.

Part of the variation in indirect taxes paid follows from differences in needs (completely beyond the control of the household), another part reflects differences in subjective tastes for which it can be held responsible. To draw a distinction between these two sets of variables, we partition the vector π_i into two subvectors: π_i^C (for the needs variables) and π_i^R (for the tastes variables). [4]

We now divide the population into K mutually exclusive groups Ω_k, $k = 1,\dots,K$, with population shares a_k, $k = 1,\dots,K$, which are *homogeneous with respect to needs*. Two households i and j from the same group Ω_k have the same

[4] It is probably easier to reach a consensus about the relevancy of this distinction than about the concrete determination of what are needs and tastes respectively. However, the exact content of these subvectors is not crucial for our theoretical framework and we may simply consider this problem to be solved by society in one way or another. See Roemer (1996) for an extensive theoretical discussion of this problem. A nice illustration of the normative question is offered by Pigou (1947)'s example, referred to by Atkinson and Stiglitz (1976). When England and Ireland were united under the same taxing authority, the Irishmen felt to be treated inequitably by higher taxes on spirits, because they preferred whiskey to beer while the Englishmen preferred beer to whiskey. Are socially influenced preferences needs or tastes?

subvector with needs variables ($\pi_i^C = \pi_j^C = \bar{\pi}_k^C$). Since it is reasonable to impose the condition that the equivalence scale only depends on the needs factors, we also get $\eta_i = \eta_j = \bar{\eta}_k$. Introducing a different tax function for each group $\tau_k(x_i, \pi_i^R) = \tau(x_i, \bar{\pi}_k^C, \pi_i^R)$ we write net equivalised expenditures for $i \in \Omega_k$ as a function y_k:

$$y_k(x_i, \pi_i^R) = \frac{x_i - \tau_k(x_i, \pi_i^R)}{\bar{\eta}_k}. \tag{3}$$

The redistributive objective of the differentiation in indirect tax rates is to reduce the inequality of equivalised net expenditures. Introducing a concave function $u(.)$, an obvious candidate for the overall social welfare function used to evaluate the redistributive effects is

$$W = \sum_k a_k \int_x \int_{\pi^R} u[y_k(x, \pi^R)] f_k(x, \pi^R) \mathrm{d}\pi^R \mathrm{d}x, \tag{4}$$

where $f_k(x, \pi^R)$ denotes the joint density of x and π^R in group Ω_k. For our empirical work we have chosen for $u(.)$ the popular isoelastic form with e as the parameter of inequality aversion.

2.1. Redistribution within and between needs groups

Given that we now have defined groups of households with homogeneous needs it makes sense to decompose the vertical redistribution through the tax system into a redistribution *within* the groups and a redistribution *between* groups. Following Kakwani and Lambert (1995) we decompose net expenditures for household i as

$$x_i - T_i = (x_i - gx_i) + (gx_i - g_k x_i) + (g_k x_i - T_i), \tag{5}$$

where g_k is the proportional tax rate within group k, obtained by dividing the sum of taxes paid within this group by the sum of expenditures within the group, and g is the proportional tax rate for the whole population. Hence, the three terms in Eq. (5) reflect three counterfactual steps in the transition from $\tilde{x}_i$ to y_i. The first step is the imposition of a uniform indirect tax system with rate g, yielding the same revenue as the actual tax system. This tax system would be distributionally neutral for all scale-invariant inequality measures. In a second step, the tax rate g is differentiated towards the rates g_k. This produces a redistribution *between* the different needs groups, but leaves the distribution *within* a group unchanged. The third step differentiates the rate g_k towards the household specific tax liability, T_i, the actual tax paid in the differentiated rate structure. This step will alter the distribution *within* each needs group.

The redistributive impact of the different steps can now be measured by means of the *equally distributed equivalent income* concept, computed on the basis of welfare function (4). We therefore define (with $h_k(x)$ the density of x in group k):

$$u(x^*) = \sum_k a_k \int_{\tilde{x}} u(\tilde{x}) h_k(\tilde{x}) \mathrm{d}\tilde{x}, \tag{6}$$

$$u(y^*) = \sum_k a_k \int_x \int_{\pi^R} u[y_k(x, \pi^R)] f_k(x, \pi^R) \mathrm{d}\pi^R \mathrm{d}x, \tag{7}$$

$$u(x^*(1-g)) = \sum_k a_k \int_{\tilde{x}} u[\tilde{x}(1-g)] h_k(\tilde{x}) \mathrm{d}\tilde{x}, \tag{8}$$

$$u(z^*) = \sum_k a_k \int_{\tilde{x}} u[\tilde{x}(1-g_k)] h_k(\tilde{x}) \mathrm{d}\tilde{x}. \tag{9}$$

The equally distributed equivalents x^* and y^* measure the overall welfare level before and after indirect taxes have been paid, while z^* measures the welfare level in the counterfactual situation where the within group proportional rates g_k are applied. We can now decompose the total redistributive impact of the indirect tax system (V) in a term which captures the redistribution within the groups (W) and a term capturing the redistribution between the groups (B):

$$\begin{aligned} V &= y^* - x^*(1-g) \\ &= (y^* - z^*) + (z^* - x^*(1-g)) \\ &= W + B. \end{aligned} \tag{10}$$

2.2. *Empirical results*

For the empirical illustration of the decomposition described above, we present some results calculated with the microsimulation model *ASTER* on the Belgian household budget survey for two indirect tax systems. The first is the existing Belgian system. [5] The second is a simple VAT-structure (without excises), in which goods with a total expenditure elasticity below unity remain untaxed and the goods with a higher income elasticity [6] get a VAT-rate such that the resulting

[5] In the uniform benchmark tax system, which is revenue-neutral to the existing Belgian indirect tax system, the tax rate g turns out to be equal to 11.5%.

[6] The following goods have a total expenditure elasticity exceeding unity: Wine, Clothing, Rent Tax Water, Electric Heating, Durables, House Maintenance, Hygienics, Use of Private Transport, Other Transport, Leisure and Services. See Decoster (1995) for more information on the expenditure elasticities.

Table 2
Decomposition of the redistributive effect of two indirect tax systems ($e = 1.5$)

	V	B	W	W_T	W_E
Existing Belgian system	794	817	−23	−515	492
Progressive system	2129	−240	2369	−168	2537

indirect tax structure yields the same revenue as the existing system. This resulted in a rate of 18.7%. [7] This latter system obviously is more 'progressive' than the actual one.

To apply the theoretical framework, a difficult decision has to be taken on the partitioning of the vector π. For our illustration, we limit the subvector of needs variables (π^C) to the variables household size and age. Households were classified in three age classes, based on the age of the household head (14–35, 35–60 and above 60), and in eight types of household size (singles with 0, 1 or 2 children in charge and couples with 0, 1, 2, 3 or 4 children in charge). Households not belonging to one of these pure classes were not used in the calculations. [8] Since the aim of this paper is not to investigate the sensitivity of the results w.r.t. the specification of the equivalence scales, we simply used the OECD-scale, in which the first adult obtains a weight of unity, each additional adult gets a weight of 0.7 and all children get an equal weight of 0.5. As it turned out that the results of the decomposition analysis are rather insensitive to the choice of different values for e, we only present in Table 2 the results for $e = 1.5$.

As could be expected, the progressive system is more redistributive than the actual structure (although both figures, which are welfare improvements measured in Belgian francs per year, are small). [9] The decomposition gives some additional insights. The existing system redistributes from needs groups with a high equivalised expenditure level towards groups with a lower equivalised expenditure level and is almost distributionally neutral within groups. In fact, a closer inspection of the results shows that the redistribution is mainly from the active couples in the middle age class (without and with children) to the singles and the older couples without children. The larger welfare improvement of the progressive system is entirely due to a redistribution *within* the different groups (from higher to lower welfare levels) and the redistribution between the groups has now even become

[7] For the simulation of these results we have chosen in *ASTER* the option of 'constant budget shares' for all commodities and households.

[8] We have used 2573 of the 3235 households in the total budget survey. The remaining sample represents 84% of the population. It is no longer representative because disproportionately more households are removed from the lower deciles of net equivalised expenditures.

[9] Remember that our sample of 'pure' needs groups is no longer representative for the Belgian population. With the full sample the actual Belgian indirect tax system is slightly regressive (see Decoster et al., 1997).

regressive. The striking differences in the W-component ask for a more detailed analysis.

3. Taste variation within groups

Since needs are constant within the groups, the W-component results from a mixture of variations in equivalised expenditures and in tastes. If we accept that households can be held responsible for the tax consequences of their subjective tastes, the existence of such a taste effect is perhaps not worrying *in se* from a normative point of view. However, as we will show now, it may have a crucial impact on the redistributive potential of the indirect tax system.

3.1. A counterfactual situation without taste differences

Let us assume that we can write the equivalised tax liability for households in group k as an additively separable function of equivalised expenditures and taste variables:

$$\frac{\tau_k(x_i, \pi_i^{\mathrm{R}})}{\overline{\eta}_k} = \left[\tau_k^1(\tilde{x}_i) + \tau_k^2(\pi_i^{\mathrm{R}})\right]. \tag{11}$$

We normalise the functions τ_k^2 such that $\int_{\pi^{\mathrm{R}}} \tau_k^2(\pi^{\mathrm{R}}) m_k(\pi^{\mathrm{R}}) \mathrm{d}\pi^{\mathrm{R}} = 0 \ \forall k$, where $m_k(\pi^{\mathrm{R}})$ gives the density of π^{R} in group k. [10] This normalisation implies that substituting the tax scheme $\overline{\eta}_k \tau_k^1(.)$ for $\tau_k(.)$ is a revenue-neutral operation.

The decomposition of the tax process into three sequential steps (as in Eq. (5)) can then be pushed further by decomposing the third step again into two substeps:

$$x_i - T_i = (x_i - gx_i) + (gx_i - g_k x_i) + \left(g_k x_i - \overline{\eta}_k \tau_k^1(\tilde{x}_i)\right) + \left(\overline{\eta}_k \tau_k^1(\tilde{x}_i) - \tau_k(x_i, \pi_i^{\mathrm{R}})\right). \tag{12}$$

We have now four terms in the transition from gross to net expenditures. The first two terms are the same as in Eq. (5) and reflect the effect of a revenue-neutral uniform indirect tax system and the effect of between-group differentiation respectively. The third and the fourth terms split up the redistribution *within* each group into a component which results from the variation in equivalised expenditures (the third term) and a component which follows from taste variation within the group (the fourth term). The distribution of welfare obtained after the third step can then be interpreted as the one which would be obtained with the tax scheme *if there would be no taste differences.*

Taste differences lead to a spread of the tax liabilities for two households i and j with the same equivalised level of expenditures ($\tilde{x}_i = \tilde{x}_j$) around a hypothetical

[10] This normalisation is always possible by simply adding a constant to the τ_k^1-scheme.

τ_k^1-function. A priori we can expect that the concavity of the function $u(.)$ will translate this spread into a welfare loss. [11] The welfare impact of this intermediate step can be measured in a straightforward way by defining another equally distributed equivalent income concept, $\hat{y}^*$:

$$u(\hat{y}^*) = \sum_k a_k \int_{\tilde{x}} u(\tilde{x} - \tau_k^1(\tilde{x})) h_k(\tilde{x}) \mathrm{d}\tilde{x}, \tag{13}$$

which results in the following decomposition of W in Eq. (10):

$$W = y^* - z^* = (y^* - \hat{y}^*) + (\hat{y}^* - z) = W_{\mathrm{T}} + W_{\mathrm{E}}. \tag{14}$$

The first term, W_{T}, measures the welfare change because of redistribution related to taste differences. The second term, W_{E}, measures the welfare change which *would be* obtained if there would be no taste differences. From a normative point of view this interpretation of differential treatment of households within the same needs group only rests upon the concern that the redistributive power of indirect taxes would be greater without taste variation, not on a concern for discrimination as such.

3.2. Empirical results

We have estimated with OLS the following regression for each group k: [12]

$$\frac{T_i}{\eta_k} = \alpha_k + \beta_k \tilde{x}_i + \gamma_k \tilde{x}_i^2 + \varepsilon_i \quad \text{for} \quad i \in \Omega_k, \tag{15}$$

where ϵ_i is a disturbance term. The two components of Eq. (11) are then calculated as:

$$\begin{aligned} \tau_k^1(\tilde{x}_i) &= \alpha_k + \beta_k \tilde{x}_i + \gamma_k \tilde{x}_i^2, \\ \tau_k^2 \pi_i^{\mathrm{R}}) &= \varepsilon_i \end{aligned} . \tag{16}$$

Given that the subjective tastes will mainly capture idiosyncratic factors it is reasonable to put them into the disturbance term. This has the additional advantage that the normalisation rule for the τ_k^2-function is satisfied automatically.

The last two columns of Table 2 show the results of the decomposition in Eq. (14). We know already that the more progressive system obtains its redistributive

---

[11] If the τ_k^1-function gives the average value of τ_k at each level of x_i, taste differences necessarily lead to a welfare loss, since the move from τ_k to τ_k^1 can be seen as a mean preserving equalising transfer (for a proof, see Kakwani and Lambert (1995)). Since we will use a regression technique to determine τ_k^1 this proof does not apply to our case, but the general intuition remains valid.

[12] The quadratic specification is chosen because of its good empirical fit (results can be obtained from the authors). It is not difficult to show that it follows from a model where the Engel-curves for commodity v and individual i are given by

$$\frac{p_v q_{vi}}{x_i} = a_v + b_v x_i + c_v \left(\frac{1}{x_i} \right).$$

power mainly from redistribution within the groups. The last column now shows that this strong redistributive effect is mainly due to the variation in equivalised expenditures. This is not surprising given that we have defined the system on the basis of the expenditure elasticities of the commodities. But the second column shows that there is also another effect: the variation in subjective tastes has only a very small impact on the redistributive power of the progressive system (perhaps because it is so simple?). On the other hand, the actual Belgian system *would* be redistributive within groups in the counterfactual situation without taste differences. It is precisely because of the variation in subjective tastes that it loses its redistributive potential within groups.

4. Conclusion

The variation in the taxes paid by different households in a differentiated indirect tax system does not only reflect differences in total expenditures but also differences in preferences. From a normative point of view, there are good reasons not to put all preference factors in the same box. Households at the same welfare level should not be treated differently by the indirect tax system, if the differences in consumption bundles are caused by needs factors. On the other hand, differences in tax burdens related to purely idiosyncratic variation in subjective tastes might be seen as rather unproblematic.

We propose to divide the population into mutually exclusive groups which are homogeneous with respect to needs. Vertical redistribution can then be split in a meaningful way into a within- and a between-groups component. Preference variation within a group can be related exclusively to subjective tastes. Although such taste variation is not ethically problematic *in se*, it will generally lower the redistributive potential of the differentiation in indirect tax rates.

An empirical calculation of these effects necessitates the use of detailed information on expenditures and preference characteristics at the household level. We used the microsimulation program *ASTER* to analyse the characteristics of the highly differentiated Belgian indirect tax system. To get a better insight we compared this system with a more progressive two-rate VAT yielding the same revenue. It turns out that the actual system redistributes between groups but that there is almost no welfare gain from within-group redistribution. This is mainly caused by the variation in subjective tastes. The simpler two-rate system is much more redistributive: this is explained by the more progressive rate structure, but also by the fact that it largely avoids the negative effects of preference variation within the needs groups.

Acknowledgements

This research has been supported by the National Research Program in Public Economics of the DWTC (contract PE/01/008).

References

Atkinson, A. and J. Stiglitz, 1976, The design of tax structure: Direct versus indirect taxation, Journal of Public Economics 6, 55–75.

Decoster, A., 1995, A microsimulation model for Belgian indirect taxes with a carbon/energy tax illustration for Belgium, Tijdschrift voor Economie en Management 40, 133–156.

Decoster, A., E. Schokkaert and G. Van Camp, 1997, Horizontal neutrality and vertical redistribution with indirect taxes, in: S. Zandvakili, ed., Taxation and inequality, forthcoming.

Fleurbaey, M., 1995, Equality and responsibility, European Economic Review 39, 683–689.

Kakwani, N.C. and P. Lambert, 1995, Vertical equity and horizontal inequity: A new approach to measurement, IFS working paper series W95/2 (Institute for Fiscal Studies, London).

Pigou, A.C., 1947, A study in public finance (Macmillan, London).

Roemer, J., 1996, Theories of distributive justice (Harvard University Press, Cambridge, MA).

Yitzhaki, S., 1994, On the progressivity of commodity taxation, In: W. Eichhorn, ed., Models and measurement of welfare and inequality (Springer-Verlag, Berlin) 448–466.