

WHAT MAKES PERSONAL INCOME TAXES PROGRESSIVE? THE CASE OF BELGIUM¹

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ABSTRACT

In this paper we investigate the progressivity impact of various components of the Belgian personal income tax system, before and after a major reform of this system. The reform reduced the top tax rates, broadened the tax base and increased tax credits. We show that, contrary to the opinion, commonly expressed in public debates, the reform did not reduce aggregate liability progression of the system and that the rate structure is relatively unimportant in explaining progressivity.

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KEYWORDS: Personal Income Tax, Tax Reform, Progressivity.

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1. INTRODUCTION

Following many other Western countries, the Belgian policy maker recently implemented a substantial personal income tax cut for the Belgian taxpayers. Not surprisingly, one of the major questions in the public discussion, concerns the effects of the reform on progressivity and/or redistributive effect of the tax system. What may come as a surprise, is the fact that the answer to these questions is less obvious. Indeed, the results of Jakobsson (1976), Fellman (1976) and Kakwani (1977) provide us with important links between the properties of a tax schedule (e.g. an increasing average tax rate) and measures of progression and/or redistribution³. Yet, the analyst, trying to apply these theorems to a real world income tax, quickly runs into difficulties.

The first difficulty follows from the attractive feature of the Jakobsson-Fellman results being "distribution-free", i.e. to hold for any underlying income distribution. The price to be paid for this generality is to be found in what became to be known in the literature as the "local" character of the progressivity measurement. One measures tax progressivity (and redistribution) at a given gross income level. Often, however, one also wants to measure aggregate progressivity across the whole distribution of gross incomes. Since this inevitably rests on some kind of aggregation through the income scale, these measures of aggregate progressivity will typically not be distribution free, but dependent on the underlying distribution.

Second, the mentioned theorems are worked out for "net" or "final" tax liabilities. In the real world, this final tax liability typically follows from a sequence of steps in the tax calculation: definition of the taxable base through allowances and deductions, application of tax rates in a number of tax brackets, reduction of the tax liability by, eventually refundable, tax credits, etc. The theorems on local progressivity do not disentangle progressivity into its components. Yet, both in the current tax reform, as in the major reform of 1988, the reform is composed of an opaque mix of measures, leading to a considerable change in the relative importance of various components of the personal income tax (PIT) system.

Between 1988 and 1993, e.g. several deductions and a basic allowance, in the form of a zero rate bracket, were abolished. The consequent broader tax base was imported into a different tax scheme with less brackets and lower marginal rates at the top. Several new, non refundable, credits were installed after the reform. The abolished zero rate bracket was replaced by a basic exemption which is designed in function of household size, and in fact acts as a non refundable tax credit⁴. Some of the abolished deductions were also compensated for with a tax credit in the reformed system. Next to these liability

³ For a sound overview of these theoretical results, see Lambert (2001).

⁴ We use the term "zero rate bracket" and "basic allowance" interchangeably. This implies that the tax "scheme" only consists of brackets with strictly positive marginal rates. With "basic exemption" we refer to the non refundable tax credit, calculated as the tax liability on the amount of income which is exempted from taxation. We explain the difference in detail in section 3.

reducing credits the government also installed a crisis surcharge of 3% on all tax liabilities. Needless to say that it is far from easy to predict the combined effect of all these pieces of reform on progressivity and redistribution.

Also the reform, currently under way, acts simultaneously on several components of the tax system. First, the top marginal tax rates (52.5% and 55%) are abolished, while the middle tax brackets are widened considerably. Second, a refundable tax credit is introduced. Over a range of low labour incomes, this tax credit first gradually increases with income, stays constant over a range to decrease again gradually. Third, the discrimination between a married couple and a cohabitating couple is removed. On the one hand, the tax exemption for a married couple will be set at the level of two (possibly cohabitating) singles and taxes on non-labour incomes (income from financial assets or property) of married individuals will be levied separately. On the other hand, the marital quotient - the possibility of shifting taxable income between spouses - will be equally applicable for cohabitating singles.

In this paper we focus on the decomposition of progressivity into contributions of different components of the tax system. Due to data limitations we are confined to an application of the reform of 1988-1993. But the general and qualitative nature of the conclusions, combined with the similarity of at least part of the measures in both reforms, will undoubtedly allow to draw lessons for the more recent reform.

The first point, mentioned above, suggests that there are two possible routes. Either one tries to broaden the scope of the Jakobsson-Fellman theorems to adapt them for a decomposition analysis. This is the path chosen by Keen, Papapanagos and Shorrocks (2000), yielding general results in terms of local measures. Or, one decomposes measures of aggregate progressivity, along the lines developed in Pfähler (1987, 1990).

Keen, Papapanagos and Shorrocks (2000) have shown that base broadening (lower allowances, elimination of deductions) never leads to a uniform increase in local liability progression⁵. An increase in non refundable credits always leads to a uniform increase in local liability progression⁶. Base broadening leads to an increase in local residual progression if the tax scheme is "progressive enough"⁷. Increasing non refundable credits always leads to a uniform increase in local residual progressivity if the tax scheme is flat⁸. Hence, their conclusions on base broadening and rising credits under *ceteris paribus* conditions either contradict or apply, in their generality, on non reconcilable

⁵This statement is a combination of the reverse of propositions 4 and 7 given in Keen, Papapanagos and Shorrocks (2000).

⁶See proposition 9 of Keen, Papapanagos and Shorrocks (2000).

⁷To see this, reverse propositions 5 and 8 of Keen, Papapanagos and Shorrocks (2000). Being "progressive enough" is a translation of the technical condition that $t'(u)/(u-t(u))$ is non-decreasing in u , where u is pre tax income and $t'(u)$ the first derivative of the tax function $t(u)$.

⁸See proposition 9 of Keen, Papapanagos and Shorrocks (2000).

conditions. Moreover, these results have been derived under the assumption of an unchanged tax scheme which is clearly not satisfied for the Belgian tax reform. At this moment, no theoretical analysis has been scaffolded to deal with the simultaneous move of changing tax rates, base broadening and changes in tax credits. Therefore, we will follow the second approach, basically empirical in nature, and leading to a decomposition of aggregate measures of progressivity and redistribution. Needless to say that our choice to follow the second track leads to insights which are less easy to generalize.

The tools for such an empirical exercise are in Pfähler (1987, 1990). He demonstrates how the Kakwani index of aggregate liability progressivity can be decomposed into a tax base and a tax rate effect. Taking this analysis some steps further, one can decompose the disproportionality of net tax liabilities into contributions made by tax system components such as allowances, deductions, rates and credits. In fact, each component contributes to the disproportionality of the net tax liabilities both through its own disproportionality and through the relative weight attached to it. Hence, applying this decomposition on the system before and after a tax reform provides insight in the changing relative importance of the various components in generating the final progressivity and redistribution of the tax system. A decomposition along these lines has been presented by Loizides (1988) for Greece, by Gelardi (1998) for Canada and by Wagstaff and Van Doorslaer (1997) in a comparative analysis for fifteen OECD countries. The basic results of the Wagstaff and Van Doorslaer paper are that a) there is substantial variation between the 15 countries in the weight they place on the following four instruments to produce progressivity or redistribution in the personal income tax system: the rate structure, tax allowances, deductions and tax credits; and b) that Belgium, together with e.g. Germany and Sweden, belongs to a group of countries for which the global progressivity quite evenly rests on three elements: rates, allowances and tax credits. Only about one third of the observed progressivity being explained by the rate structure, the rates only play a limited role in the progressivity of the personal income tax system. The other two thirds are evenly rooted into tax allowances and tax credits. Other countries mainly rely on the tax rates (examples are the Netherlands and Spain), while a third group (e.g. UK and US) produces the progressivity mainly by using the basic allowance component.

Although Belgium was part of the set of countries, analyzed by Wagstaff and Van Doorslaer (1997), we redo their analysis to some extent. We have several reasons for this. First, they analyze the Belgian PIT system before the important reform of 1988. Their data refer to the second half of the eighties. And this is precisely the period in which many OECD countries experienced major changes in their personal income tax systems. In the case of Belgium, the data are from 1987, while in December 1988 a major tax legislation change has been voted, to become effective in 1989. Our aim is to cover the reform(s) of the PIT system that have been installed between 1988 and 1993 and to allocate the changes in progressivity to different elements of the reform. Moreover, in their ambition to lay down a comparative analysis over the OECD countries, Wagstaff and Van Doorslaer had to restrict themselves to aggregate data, published by the OECD (OECD, 1990). Our progressivity decomposition rests on microdata of a representative sample of 10,343 Belgian taxpayers. Finally, the use of this large sample also allows two other empirical

advances compared to the Wagstaff and Van Doorselaer analysis for Belgium. We can apply the statistical tools of Bishop, Formby and Zheng (1998), to judge whether the changes in the progressivity measures are statistically significant or not. And we can introduce equivalence scales to take household size into account.

Next to the decomposition of the tax system into its various components, the second aim of the paper is to assess the redistributive impact of the PIT reform itself. Belgium did not stand aloof from the wave of personal income tax reforms which swept the Western economies in the eighties. The Belgian reform did not differ significantly from the predecessors on which it was inspired (the main example being the Tax Reform Act of 1986 in the US). In the US, TRA86 (the conventional abbreviation for the tax reform act of 1986) has been analyzed and scrutinized in numerous empirical analyses⁹. Despite the formulated objective of distributional neutrality, the main conclusion seems to be that base broadening and reduction of the top rates, have slightly increased the progressivity of the system¹⁰. Nonetheless, some dissonant voices have been heard in the US as well, underlining the regressive character of TRA86¹¹. For the UK, Giles and Johnson (1994) find a regressive impact of the income tax reform¹². For Sweden, the evidence provided by Palme (1996) for the tax reform of 1991 points towards a reduction of the progressivity¹³. And Gelardi (1998), analyzing a Canadian reform which was very similar to the Belgian one, finds that liability progression was approximately constant. In sum, the evaluations of foreign, but similar, reforms provide mixed evidence on the subject.

As far as we know this kind of analysis has not been done yet for the Belgian tax system, and this paper tries to fill this gap. In Decoster and Van Camp (2001) we found that the PIT reforms of 1988 slightly eroded the redistributive effect of the PIT-system, not because of reduced progressivity (quite the contrary, it increased slightly), but only because of the lower average tax rate. The analysis in this paper uses other data and is more refined. In Decoster and Van Camp (2001) we used household budget data to be able to calculate indirect tax liabilities. Here we dispose of data on taxpayer units. Secondly this paper tries to explain why and how the progressivity of the Belgian PIT-system could slightly increase, although major changes, such as the reduction of the top marginal rates, have been interpreted publicly as a regressive move of the personal income tax system.

One of the reasons for the mixed evidence, obtained in the empirical analysis of tax reforms in other countries is undoubtedly to be found in different assumptions underlying

⁹ A broad overview of the extensive literature can be found in Auerbach and Slemrod (1997).

¹⁰ This evidence of increased progressivity confirms the expectations formulated at the time of the conception of TRA86 (see Pechman (1987)). For detailed evidence on the enhanced progressivity and/or redistribution, triggered by TRA86, see among others Ballentine (1986), Feldstein (1988), Pechman (1990) and Kasten, Sammartino and Toder (1994). The latter paper sails a bit between confirmation and denial of enhanced progressivity, depending on the assumptions made about the behavioural response to TRA86.

¹¹ See Gramlich, Kasten and Sammartino (1993), Gravelle (1992) and Bishop, Chow, Formby and Ho (1997).

¹² Giles and Johnson (1994) consider the period 1985-1995. For the period 1979-1986, by contrast, Bishop, Formby and Zheng (1998) state that the redistributive character of the UK-system has increased.

¹³ This result is confirmed by Bishop, Formby and Zheng (1998).

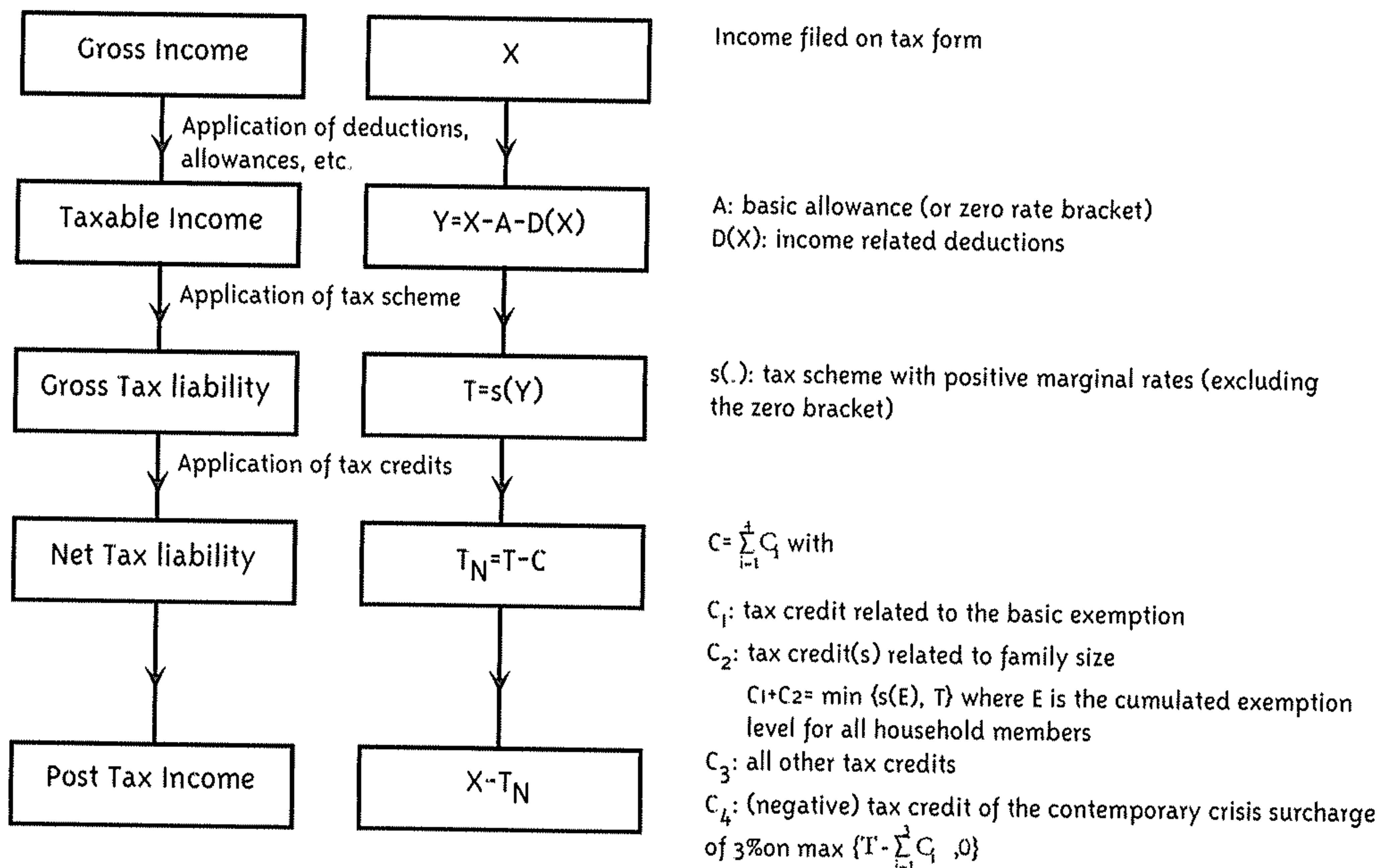
the simulations or models used to calculate the effects. The overview in Auerbach and Slemrod (1997) shows that the changing pre tax distribution, the integration of behavioural responses in the model and the assumptions concerning the incidence of the corporate income tax, can crucially affect the outcome. In this paper we focus on the decomposition of the tax structure as such, and not on the change in inequality between 1988-1993. Therefore we have kept the pre tax distribution fixed and neglected behavioural responses¹⁴. The absence of a microsimulation model for corporate income taxes in Belgium explains our limitation to PIT.

The simulated reforms are discussed in section 2. Section 3 deals with the data and the simulation model that has been used. In section 4 we set out how the disproportionality of net tax liabilities can be disentangled into the contributions of the various tax system components. This methodology is applied in section 5 to assess the Belgian tax reform. Section 6 concludes.

2. A DECOMPOSITION OF THE TAX SYSTEM

Figure 1 summarizes the transition of gross income to income net of taxes through the personal income tax system and the notation used for the decomposition of the different components.

FIGURE 1: SEQUENCE AND COMPONENTS IN THE PERSONAL INCOME TAX SYSTEM



¹⁴ This is by no means the only way of sorting out the contribution of the tax structure from the influence of the income distribution in the observed progressivity. For a theoretical analysis to disentangle both effects see Seidl (1994).

We capture the redistributive effect and the progressivity of the PIT system by two of the most popular progressivity measures, i.e. measures of aggregate liability and aggregate residual progression¹⁵. The basic ingredients of these measures are the pre-tax Lorenz curve and the concentration curves of net tax liabilities and post tax income. In contrast with Decoster and Van Camp (2001) where we worked with dominance relationships between the curves themselves, we have chosen here the index approach. The only reason is to be able to focus on the decomposition itself.

The Reynolds-Smolensky measure of residual progression, denoted here as Π_N^{RS} , with the subscript N denoting the "net" or final tax liability, spans the whole transition process from gross income to income net of taxes in figure 1. Essentially it is a weighted average of the vertical distance between the pre-tax Lorenz curve and the concentration curve of post tax income, and in the absence of reranking, it can be interpreted as the reduction of the Gini coefficient through the transition in PIT¹⁶. It is well known that this redistributive effect rests on the disproportionality of the net tax liabilities, commonly called "liability progression". The Kakwani index, denoted here as Π_N^K , measures this liability progression as a weighted average of the vertical distance between the concentration curve of tax liabilities and the Lorenz curve for pre tax income. The relation between residual progression and liability progression is:

$$\Pi_N^{RS} = \frac{t_N}{1-t_N} \Pi_N^K, \quad (1)$$

where t_N refers to the average tax rate of net tax liabilities¹⁷. In fact, (1) provides us with the first step in the decomposition of the redistributive effect of PIT: the interplay of the average tax rate with the liability progression of the net tax liabilities. We now move up one more level in figure 1. The net tax liabilities T_N are obtained from the gross tax liabilities T from which the (non refundable) tax credits are subtracted. Hence, it does not come as a surprise that Π_N^K can be broken up into:

$$\Pi_N^K = \frac{t}{t_N} \Pi_T^K - \frac{c_1}{t_N} \Pi_{C_1}^K - \frac{c_2}{t_N} \Pi_{C_2}^K - \frac{c_3}{t_N} \Pi_{C_3}^K - \frac{c_4}{t_N} \Pi_{C_4}^K, \quad (2)$$

where each $\Pi_{C_i}^K$ denotes the disproportionality of tax credit C_i , c_i refers to the average tax credit rate, calculated as the sum of the tax credit C_i over all tax payers divided by the sum of pre tax income, and t is the average rate of gross tax liabilities. Of course $t_N = t - c$, where $c = \sum_i c_i$. If the distribution of a credit is located disproportionately in the lower end of the distribution of pre tax income, $\Pi_{C_i}^K$ is negative, which combined with the negative signs of subtraction in (2), enhances the liability progressivity of net tax liabilities. The first term in (2) gives the contribution of the liability progression in the gross tax liabilities (with

¹⁵ See Lambert (2001) for an overview of various progressivity measures.

¹⁶ Evidently, a possible extension of our analysis would include an analysis of sensitivity for the choice of normative assumptions by using the generalised (or S-) Gini of Donaldson and Weymark (1980) and Yitzhaki (1983).

¹⁷ This average rate is calculated as $\frac{\sum T_N}{\sum X}$.

an average rate t) to the final liability progression of the net tax liabilities. Obviously, using the determination of gross tax liabilities, T , as:

$$T = s(Y) = s[X - A - D(X)] \quad (3)$$

it is easy to show that Π_T^K can be further decomposed in a "rate effect", Π_R^K which captures the effect of the tax scheme $s(\cdot)$ and the disproportionality of allowances and deductions¹⁸:

$$\Pi_T^K = \Pi_R^K - \frac{a}{1-a-d} \Pi_A^K - \frac{d}{1-a-d} \Pi_D^K \quad (4)$$

The measure Π_R^K captures the disproportionality between taxable income, $X-A-D$ on the one hand and T on the other hand. Pfähler (1990) refers to this as the 'direct' progressivity effect in his decomposition of the disproportionality of gross tax liabilities. Direct progressivity, or the rate effect, originates from the application of the tax scheme on taxable income. The rate effect thus measures the disproportionality between what goes in and what comes out of the tax scheme. The measures Π_A^K and Π_D^K measure the disproportionality of allowances and deductions as compared to X . In order to sum these 'indirect' progressivity effects with Π_R^K and to obtain Π_T^K the indirect progressivity terms have to be weighted by the average allowance and deduction rates. These average rates are denoted by a and d in (4).

Since the tax scheme itself is the component of the PIT system which is most often quoted, at least with the general public, presumably many people have in mind only the rate effect, when they refer to the progressivity of PIT. Note however, that purging out the effect of credits, deductions, exemptions, and allowances from the progressivity of net tax liabilities to obtain a "pure" rate effect does not free the measure Π_R^K from the empirical contingency of being dependent on the pre tax income distribution¹⁹.

We applied significance tests on these various disproportionality indexes, as described in Bishop, Formby and Zheng (1998). They prove the asymptotic normality of these indexes and provide the necessary expressions to calculate the standard errors.

¹⁸ Before the reform the allowances only cover the zero rate bracket (see section 3), while all other differences between pre tax income and taxable income are captured by the deduction term.

¹⁹ Note that the decomposition presented here may suffer from the trade-off between two desirable properties of marginality and consistency, described in the context of inequality decomposition in Sastre and Trannoy (2002) and Shorrocks (1999). Both papers also present a fresh methodology, based on Shapley decomposition, to reconcile both properties. But, analogous to earlier doubts on the possibility to carry over the methodology of decomposition by factor components (see Shorrocks, 1982) to a tax decomposition, it is not clear whether this new method will improve the decomposition methodology for the issue at hand.

3. THE BELGIAN TAX REFORMS OF 1988-1993²⁰

First of all, in an attempt to broaden the tax base, taxable income is determined in a different way before and after the reforms. The major element in this respect took place in 1988: the zero rate bracket has been abolished and replaced by basic exemptions, entitling the tax payer to tax credits. The 1988 reform also tightened the possibilities to deduct itemized costs from professional income such as expenses on visiting restaurants and professional clothing. Further base broadening took place in 1993, so that the deduction possibilities apart from the basic allowance, are more restricted after the reforms: on average, deductions made up 16.5% of pre tax income before the reforms and 14.3% after the reforms.

The main changes were the following: expenses on life insurance contracts that were previously treated partly as a deduction and partly as a tax credit are entirely treated as a tax credit after the 1993 reform. This has led to a tightening of the compensations for life insurance contracts in the tax system after the reforms. In the 1988 PIT system one could deduct capital redemptions due to mortgage loans and contributions to private pension funds. The 1993 PIT system compensates for all these components by giving tax credits instead of a deduction.

In order to calculate the credits after the reform one adds expenses on life insurance contracts and mortgage loans for each spouse. The maximal amount of expenses that can be taken into account for each spouse is BEF 66,000 (1633.7 €). Expenses on private pension funds are limited up to an amount of BEF 22,000 (544.6 €). These amounts are translated into a tax reduction by multiplying them with a rate which varies, in principle, with the total amount of income of each spouse and which is limited between 30 % and 40 %. In some cases this rate is the highest marginal tax rate.

The reform also increased the upper limit for the deduction for charity gifts. Expenses for child care (younger than 3 years) can be deducted after the reform while this was not the case before.

Secondly, taxable income is imported into different tax schemes before and after the reforms. Two major differences in the tax scheme can be distinguished. First, a thorough restructuring of the tax rates and brackets, and secondly, full separate taxation.

In 1988, the tax scheme has been reformed into broader and less brackets, and lower marginal tariffs at the top. The number of tax brackets has been reduced from 14 to 7 after the reform. Especially, the changes for the higher income levels are striking. Before the

²⁰ We sketch the major differences between the 1988 and 1993 PIT system. Hence, as a way to speak, the reform refers to all the measures that have been implemented between 1988 and 1993, although they have not been realised by a single tax reform act. The main act has been voted on December 7th 1988, to become applicable on the incomes from January, 1st 1989 on. Note that if we refer to 1988 or 1993 for the PIT system, this implies reference to the administrative tax years 1989 or 1994, respectively.

reform one applied 4 different rates ranging from 56.5% to 70.8%, on income above BEF 1,574,000 (39,018 €)²¹. After the 1988 reform, these income levels only faced rates of 52.5% or 55%.

Full separate taxation of professional income and the creation of the "wedding - fraction" for spouses was one of the core elements of the 1988 PIT reform. Before the 1988 reform a rather low joint income ceiling determined whether professional income of a two-income earner family was taxed jointly or separately. Above the threshold, joint taxation for married couples was the rule, which in a progressive system could lead to a large discrepancy in the amount of taxes paid by a married couple as compared to a cohabitating, but non - married, couple. To cope with this problem, the new system attributes to each partner the income components that are associated with his own professional activity. This separate income concept covers wages and salaries paid to employees, replacement incomes such as unemployment benefits and retirement pensions. Other sources of income, such as real estate income are still attributed to the partner with the highest amount of professional income. Families with only one income earner can benefit from the "wedding - fraction", designed to cope with unequally distributed household income. If one of the spouses earns less than 30% of the total amount of professional income of the couple, this partner is attributed an amount as if he would have earned this 30%²². The income of the other partner is reduced with this amount. This reshuffling of taxable income among spouses is limited to an amount of BEF 297,000 (7,362 €) in the 1993 PIT system.

Finally, also the tax credits have undergone a great deal of doctoring. We have already mentioned the abolition of the basic allowance in the form of a zero rate bracket. This change may have considerable distributional consequences. In a graph with tax liability on the vertical, and taxable income on the horizontal axis, a zero rate bracket can be considered as shifting the tax schedule *to the right*. The zero rate acts in fact as a deduction, which implies that in a progressive system, the effect of the zero rate bracket increases with taxable income. Tax credits, on the contrary, are calculated as reductions of the tax liability. They shift the tax schedule *downwards*. The effect of a tax credit throughout the income scale depends on the precise form in which the reduction is calculated. In the system before the reform of 1988, for example, the tax reductions for dependent children were calculated as percentage reductions of the tax liability, be it between a minimum and a maximum. And as we saw above, the tax credits introduced for expenses on life insurance contracts, capital redemptions of mortgage loans, and private pension funds, are all calculated as a rate, either average or marginal, applied on the amount of expenses. This is not the case for the tax credit which is substituted for the zero rate bracket. This tax credit is calculated as $Min(s(E), T)$, in which E stands for the exemption level. That means that the tax reduction is calculated at the rate, applying at the bottom of the schedule²³.

²¹ To express nominal figures of both systems at the same level, we used the change in the consumption price index. This index increased from 100 to 115.8 between 1988 and 1993. See Ministerie van Financiën (1994), p. IV.4.

²² Note that this system also applies for two income earner families, if the wedding fraction produces a lower tax liability than separate taxation does.

²³ Therefore these tax credits are sometimes called "exemptions from the bottom up".

The exemption level itself is made a function of household composition (i.e. being married and having dependent children). The basic exemption in 1993 amounts to BEF 186,000 (4,611 €) for a single person, and BEF 146,000 (3,619 €) for each partner of a married couple. Dependent children push the exemption level up by BEF 39,000 (967 €), BEF 62,000 (1,537 euro), BEF 127,000 (3,148 €) and BEF 141,000 (3,495 €) for the first, second, third and fourth child respectively. Each extra child increases the exemption level with another BEF 141,000 (3,495 €). These exemption levels (and implied tax credits) replace the tax credits for dependent children that existed before the reforms. In order to compare the family type compensations before and after the reforms we have disentangled the exemptions in two parts. The tax amount that corresponds with the basic exemption of a single person or a married couple is referred to as the basic exemption, and denoted C_1 in Figure 1 and subsequent results. The family type credit of the reformed system is defined as the amount that exceeds this basic exemption, and denoted C_2 . As said above, the reforms also translated a number of deductions, such as expenses on life insurance contracts, capital redemptions due to mortgage loans and contributions to private pension funds, into tax credits. We have collected all other tax credits in C_3 . Finally, to ensure the budget consolidation in view of the "Maastricht" convergence criteria, a "temporary" crisis surcharge was introduced in 1993, which inflates all "final" tax liabilities by 3%²⁴. We denote this negative tax credit by C_4 .

4. THE DATA AND SIMULATION OF THE REFORMS

We have used the microsimulation model SIRE, to simulate the Personal Income taxes, before and after the reforms²⁵. SIRE uses a sample of administrative data, consisting of 10,343 tax forms, entered in 1994²⁶. As a consequence, the units of observation are of an administrative type. In principle these units are individuals, since each Belgian citizen that is gaining a sufficient amount of income has to enter a tax form. However, married couples only enter a single tax form. People with income below a certain threshold do not have to enter a tax form²⁷. Obviously, the absence of this bottom tail of the distribution is a most deplorable limitation of this fiscal data set, and should be taken into account when interpreting the results. Due to this limitation, 13% of all Belgians are not represented in the sample²⁸.

For each unit of observation in our sample we observe a complete tax file, that was entered for the tax year 1994. This implies that we observe all information, required to calculate the taxes paid by that unit of observation for the tax year 1994. We not only used these data to calculate the taxes paid in 1993, i.e. the tax year 1994, but also to calculate the taxes paid in 1988. To simulate the taxes of the 1988 tax system we simply applied the 1988 tax rules on income data from the tax year 1994.

²⁴ At the time of writing, a new tax reform was launched. One of the elements of the new reform is to abolish this "temporary" (negative) tax credit. From the tax year 2000 on, the applied rate of 3 % will gradually be reduced over the next tax years, aiming at a complete abolishment of the negative tax credit by the tax year 2004.

²⁵ See Standaert and Valenduc (1996) for more information on SIRE.

²⁶ Hence, the reported income figures are expressed in prices of 1993.

²⁷ For some people, such as those receiving only replacement income, it is obvious that they will not have to pay income taxes if their income sources do not change. These people no longer receive a tax form after a number of years. They should only contact the administration if their status changes.

²⁸ See Standaert and Valenduc (1998), p. 1.

Gross income has been kept constant to simulate tax liabilities of both tax systems. Keeping this income concept fixed has the advantage that before and after reform tax systems are compared to the same pre tax income distribution. But, in general, this gross tax income concept has the disadvantage that it is limited to income components that appear on the tax form. Income components that are entirely exempted, such as child allowances, do not end up in the tax form and hence not in our gross income concept. It is hard to estimate an average amount of exempted income. In Verbist (2002), the average amount of equivalised gross income, from labour supply, real estate income, alimony payments and transfers in Belgium in 1997 is estimated to be BEF 855,900 (21,186.2 €). From this amount, BEF 33,100 (819.3 €) or some 3.9% comes from income sources that are exempted such as social assistance benefits, child allowances and study allowances.²⁹

5. EMPIRICAL RESULTS

All concepts of analysis have been equivalised by means of the OECD equivalence scale³⁰. Households are ordered on the basis of equivalised pre tax income. The results of the decomposition are given in figure 2. The notation refers to the one used in equations (1), (2) and (4). All figures appear as couples: the uppermost one refers to the pre reform situation, the figure below is the one after the reforms. We have calculated the standard errors as described in Bishop, Formby and Zheng (1998) but do not present them, for the simple reason that all figures and the differences between pre and post reform values (except one) are statistically different from zero at a significance level of 5%³¹.

5.1. REDISTRIBUTIVE EFFECT AND NET LIABILITY PROGRESSION

We start the discussion of the results at the top of figure 2. The Reynolds-Smolensky measure takes a value of 0.0513 before the reforms. With a Gini of pre tax equivalised incomes of 0.337, and speaking loosely by leaving out the reranking component, this means that before the reforms the PIT system lowered the Gini from 0.337 to 0.286³². The first conclusion is that the PIT reforms have not eroded the redistributive power of the PIT system. Quite the contrary, the Reynolds Smolensky measure increased, although very slightly (but statistically significant different from zero).

Yet, this near constancy of the redistributive effect has been the result of two opposing forces: a substantial increase of the liability progression of net tax liabilities and a decrease of the average tax rate. This second conclusion shows up on the second level of figure 2. It illustrates the importance of (1) and the need to specify exactly what one means when using the words

²⁹ See Verbist (2002), p. 125.

³⁰ In this scale, the first adult is given a value of 1, each consecutive adult gets a weight of 0.7 and children count for 0.5. Normally one is considered a child until the age of 13. Since the age information in our data set was not sufficient to apply this rule, we gave a weight of 0.5 to all dependent children of the tax payer.

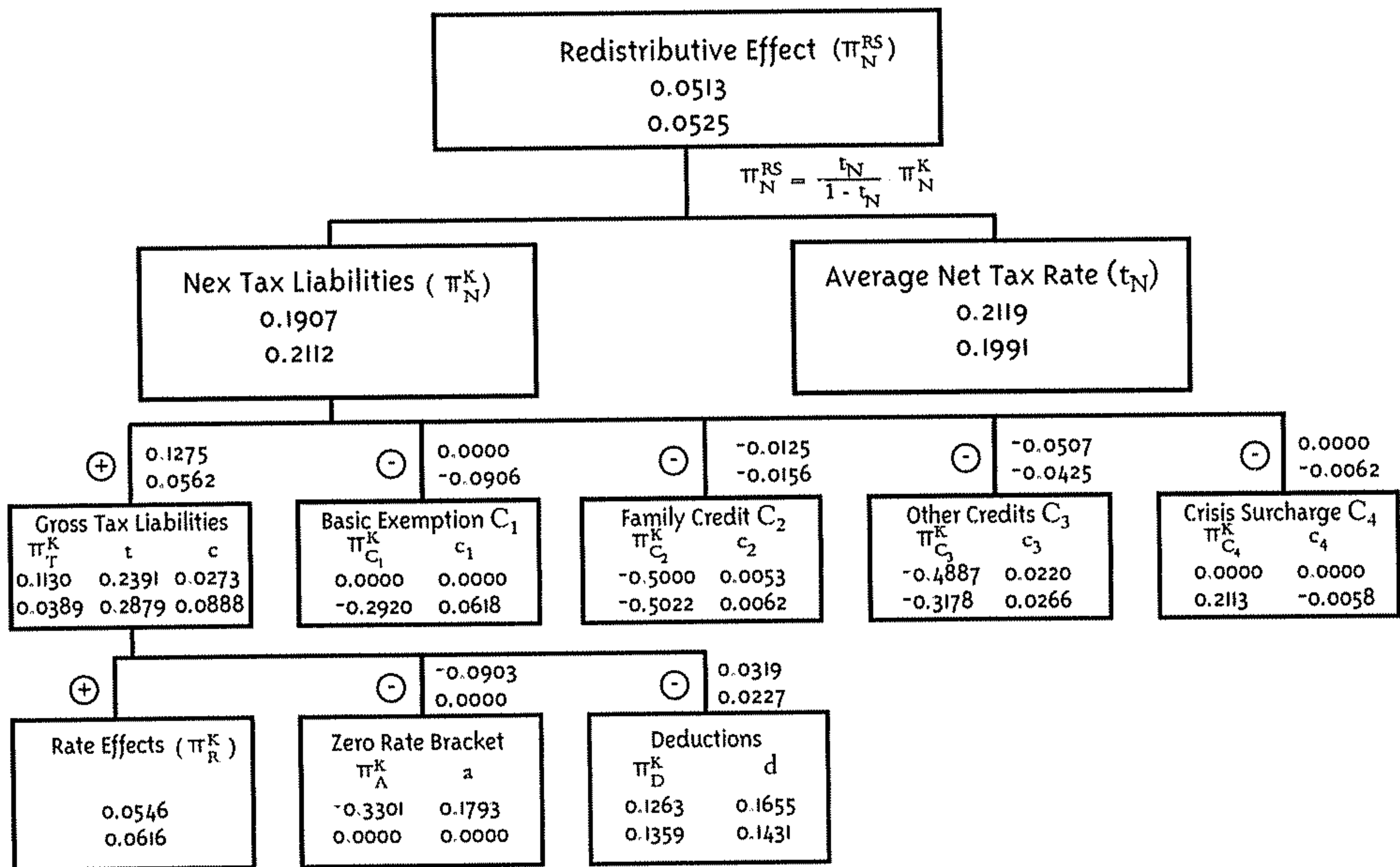
³¹ There is only one difference between pre and post reform value, which is not significant: the difference of the Kakwani index of the family credits.

³² The reranking component has been checked and is very small indeed. It varies around 0.003.

"distributionally neutral" in the discussion about tax reforms. In TRA86 in the US, e.g., one of the objectives of the tax reform was to be distributionally neutral, which was explicitly defined as "equal percentage reductions in tax liabilities at all income levels" (see McLure and Zodrow, 1987). This boils down to an unchanged liability progression. The other possibility is a definition of distributional neutrality of a tax reform by an "equal percentage change in after-tax income at all income levels". In that case, the measurement of progressivity or redistributive effect of a tax system focuses on the change in inequality of after-tax income gauged, e.g. by the Reynolds-Smolensky measure³³.

The second line of figure 2 is clear: if the redistributive effect of the PIT system has not been enhanced by the reforms, this is not due to lower liability progressivity of net tax liabilities, but only because the average tax rate has been lowered from 0.212 to 0.199. With an unchanged average tax rate the same reforms would have increased the redistributive effect of PIT considerably³⁴.

FIGURE 2: DECOMPOSITION OF THE REDISTRIBUTIVE EFFECT OF THE BELGIAN PERSONAL INCOME TAX SYSTEM BEFORE AND AFTER THE REFORMS



³³ See Formby, Thistle and Smith (1990) for a summary of the discussion and welfare interpretations of both approaches.

³⁴ Note that this finding of the important role of the average tax rate in explaining π_N^{RS} confirms conclusions based on cross-sectional comparisons. The residual progression of the Belgian personal income tax is high, when compared to other countries. It exceeds the redistributive effect of all 12 countries in Wagstaff et al. (1999). But in most cases it is the average tax rate which offers the explanation, not liability progression. The most prominent example in Wagstaff et al. (1999) is France. The French PIT is very progressive ($\pi_N^K=0.27$), and yet it leads to a limited redistribution ($\pi_N^{RS}=0.0154$). The explanation lies in the relative unimportance of PIT in France ($t_N=0.06$).

5.2. GROSS TAX LIABILITIES AND THE ROLE OF CREDITS

Going one level further down, we find out why and how the progressivity of net tax liabilities has increased. Equation (2) decomposes the Kakwani index Π_N^K into the progressivity of gross tax liabilities and four different credits. In figure 2 we present both the Kakwani indices of each component and the terms of the right hand side of (2), obtained by multiplying each Π_i^K with the appropriate weight.

Looking first at the terms of (2), net tax liability progressivity before the reforms was explained for about two thirds by the progressivity of gross tax liabilities. The remaining one third could be attributed to all kind of tax credits (C_3 , other credits, and C_2 , family credits, in order of importance). The tax reforms have changed this structure drastically. The sum of all credit contributions to Π_N^K now accounts for more than 70% of the progressivity of net tax liabilities. This shift has halved the role of gross tax liabilities. Of course this has to do with the introduction of the basic exemption. We have labelled this exemption as a "tax credit" because it is calculated at marginal tax rates of the lowest tax brackets. After the reforms this component (C_1) on its own produces 40% of the progressivity of net tax liabilities.

Once more the role of each component derives from both the average rate and the disproportionality index for this component. The importance of the basic exemption after the reforms, e.g., not only rests on the intrinsic progressivity of this tax credit (a negative sign indicating that the tax credit is distributed disproportionately in favour of lower income groups), but also on the high average rate c_1 (0.0618). The other credits (C_3) are more progressive (an index before the reforms of -0.49) but their role is more limited (c_3 equals 0.02). The larger progressivity of C_3 comes mainly from the fact that these tax credits are related to replacement incomes, which are found disproportionately more in the lower income groups. The reforms have further reduced the role of credits not related to family size, and this has gone hand in hand with a slight decrease in progressivity of these credits. This does not come as a surprise. Variable C_3 also takes up the effect of the transformation of deductions for long term saving (such as pension funds and payments for insurance contracts) into credits, after the reforms. These long term savings are of course found disproportionately more in higher income classes³⁵. The role of family credits (C_2) is rather limited. The reforms have slightly increased both their progressivity and their importance. The uniform crisis surcharge of 3% has a small regressive impact.

5.3. PURE RATE EFFECT AND THE ROLE OF DEDUCTIONS

The harsh reduction of the role of gross tax liabilities (which are tax liabilities before tax credits are applied) should be interpreted with care. The reduction has to do with the elimination of the zero rate bracket. But since the new system awards the basic allowance in the form of a tax credit, the result is to a large extent a kind of artefact.

³⁵ See Valenduc (1999) for Belgian evidence on this matter.

Moreover the reduction of the role of gross tax liabilities does *not* imply that the rate structure itself has become less important and/or less progressive. This becomes clear in the bottom line of figure 2, where the decomposition of (4) is given. The rate structure itself became more progressive (Π_R^K increased substantially from 0.0546 to 0.0616). Undoubtedly this is one of the main misunderstandings of many tax reforms. The lowering of top marginal rates attracts a lot of attention, and induces many people to conclude that liability progression has decreased. Our results seriously amend this superficial conclusion. Of course this has to do with the methodology of measuring progressivity, in which the distribution of pre tax income plays a crucial role.

As befits a tax reform which embraced base broadening as an important principle, the role of deductions has been decreased (d goes down from 0.1655 to 0.1431). But just like for the credits, C_3 , we find that the remaining deductions are located more disproportionately in the higher income groups. Yet, the increase in Π_D^K does not outweigh the reduction in d . As a consequence, the erosion of progressivity due to deductions has been reduced (i.e. $\frac{d}{1-a-d}\Pi_D^K$ goes from 0.0319 to 0.0227).

5.4. RELATIVE CONTRIBUTIONS TO PROGRESSIVITY OF NET TAX LIABILITIES

Table 1 summarizes the main findings of our decomposition. Substituting (4) for Π_T^K in (2), we have expressed the contribution of each component as a percentage of the progressivity of net tax liabilities.

TABLE 1: PERCENTAGE CONTRIBUTIONS OF THE DIFFERENT COMPONENTS TO THE PROGRESSIVITY OF NET TAX LIABILITIES (AFTER CORRECTION WITH EQUIVALENCE SCALES)

component	formula	before reforms	after reforms
pure rate effect	$\frac{t}{t-c}\Pi_R^K$	32.3	42.2
zero rate bracket	$-\left(\frac{t}{t-c}\right)\left(\frac{a}{1-a-d}\right)\Pi_A^K$	53.5	0.0
deductions	$-\left(\frac{t}{t-c}\right)\left(\frac{d}{1-a-d}\right)\Pi_D^K$	-18.9	-15.5
<i>gross tax liabilities</i>		66.9	26.7
basic exemption	$-\frac{c_1}{t-c}\Pi_{C_1}^K$	0.0	42.9
family credits	$-\frac{c_2}{t-c}\Pi_{C_2}^K$	6.5	7.4
other credits	$-\frac{c_3}{t-c}\Pi_{C_3}^K$	26.6	20.1
crisis surcharge	$-\frac{c_4}{t-c}\Pi_{C_4}^K$	0.0	2.9
<i>all credits</i>		33.1	73.4
net tax liabilities	Π_N^K	100.0	100.0

The reforms have altered the relative importance of the different components of the Belgian PIT substantially. Before the reforms, the liability progression mainly came from the progressivity of gross tax liabilities, in which the zero bracket played a major role. The credits contributed for about one third of the liability progression. After the reforms, the main role in establishing liability progression has been taken over by the tax credit, related to the basic exemption. The role of other credits and of deductions has been reduced slightly. Contrary to intuitions the pure rate effect has been enhanced.

5.5. SENSITIVITY TO THE CORRECTION WITH EQUIVALENCE SCALES

In the introduction we referred to conflicting evidence on the distributional effects of the TRA86 tax reform in the US. Among other possible explanations, Bishop, Chow, Formby and Ho (1997) also suggest that the adjustment for family size might be responsible for some of the divergent results. This should not come as a surprise. It is well known that the measurement of inequality and redistribution is sensitive to the use of equivalence scales and their specification (see Coulter, Cowell and Jenkins, 1992 and Jenkins and Cowell, 1994). Yet, no matter how difficult it is to escape critical remarks on the specific scales used, we think that, from a policy perspective at least, and if we agree on the exogeneity of household composition in this analysis, the equivalizing approach is preferred to working with uncorrected nominal incomes³⁶.

Therefore we have compared the decomposition, presented above, with the one if no correction with equivalence scales is used. As far as the decomposition of figure 2 is concerned, all major conclusions continue to hold. The contribution of gross tax liabilities now decreases from 68% to 21%, with a corresponding enhancement of the role of credits. The pure rate effect is more pronounced (it is 46% after the reforms), and the role of deductions is reduced by the reforms. The only difference in the decomposition concerns the family credits. If no correction with equivalence scales is used, their role in the progressivity of net tax liabilities disappears. The reason is the nearly exact proportionality of these tax credits with uncorrected pre tax income (the Kakwani index $\Pi_{C_2}^K$ amounts to -0.04 before and -0.03 after the reforms).

Yet, the correction for family size does play a role when assessing the final impact of the tax reforms on the redistributive effect. This is clear from table 2, where we summarize the Kakwani index of liability progression of net tax liabilities, the average tax rate, and the redistributive effect. Foregoing the correction for family size leads to the conclusion that the tax reforms eroded the redistributive impact of the PIT system. The decrease of the average tax rate is more pronounced, and the increase in liability progression is not strong enough to compensate the lower average tax rate. Again, all these differences are statistically significant different from zero. But of course the change in the redistributive effect is small, anyway.

³⁶ Of course there are other possibilities, such as working with "homogeneous" groups and applying sequential dominance criteria such as the one of Atkinson and Bourguignon (1987) or Lambert and Ramos (2002). For a recent proposal to combine both approaches: see Fleurbaey, Hagneré and Trannoy (forthcoming).

TABLE 2: COMPARISON OF LIABILITY PROGRESSION AND REDISTRIBUTIVE EFFECT WITH AND WITHOUT CORRECTION WITH EQUIVALENCE SCALES

	with correction			no correction		
	before	after	change (%)	before	after	change (%)
Π_N^K	0.1907	0.2112	+10.7	0.1663	0.1710	+2.8
t_N	0.2119	0.1991	-6.0	0.2168	0.2004	-7.6
Π_N^{RS}	0.0513	0.0525	+2.3	0.0460	0.0429	-6.7

In Decoster and Van Camp (2000) we have also checked the sensitivity of this kind of analysis to the definition of the unit of analysis (fiscal unit or sociological household) and to the addition of the bottom of the distribution of people that do not file a tax form. Although the analysis has been carried out in a slightly different empirical setting, we found that the substitution of sociological households for fiscal units, and the addition of non-filing units, did not affect the basic finding. The redistributive effect has roughly been kept constant by an increase in the liability progression which offsets the substantial decrease of the average tax rate.

CONCLUSION

Between 1988 and 1993 the Belgian government reformed the personal income tax system to a considerable extent. The basic ingredients being base broadening and flattening of the top rates, the reforms were very much in line with what happened in several other OECD countries. A broader tax base emerged because deduction possibilities became more restricted and the zero rate bracket was eliminated. Instead, the new system basically relies on tax credits. The basic allowance takes the form of an "exemption from the bottom up" and increases with family size. Since the effect of this exemption is calculated at the lowest marginal rates, it reduces in fact to a tax credit. Some deductions have been transformed into credits. Separate taxation of professional income of both spouses became the default, and a temporary crisis surcharge, increasing all tax liabilities by 3%, has been introduced.

Our empirical analysis of the Belgian reforms rests on microsimulations of the 1988 and 1993 PIT system on a single administrative data set consisting of more than 10,000 fiscal units. Our conclusions are based on equivalised data, and do not take into account behavioural responses. We have checked the statistical significance of all indexes, disproportionality measures, and differences therein. Except for the change in the progressivity of the family credits, they were all significantly different from zero.

The reforms left the redistributive effect of PIT nearly unchanged. The Reynolds-Smolensky measure even shows up with a small increase (+2.3%). But this unchanged redistributive effect masks two important offsetting changes: a substantial increase of the liability progression of the final tax liabilities (+10.7%) and a decrease of the average tax rate (-6.0%). This result underlines the crucial importance of both elements in assessing the redistributive role of PIT.

The increase in net liability progression is provoked mainly by the important role of basic exemptions, introduced in the Belgian PIT by the reforms. After the reforms this component contributes 43% of the liability progression. It replaces the zero rate bracket which was responsible for 53% of the progressivity before the reforms. The relative importance of other credits was rather unaffected.

Further decomposing the gross liability progression into a pure rate effect, a zero bracket rate effect and deductions has led to remarkable insights. Things are seldom what they seem. Moving towards a more "flat rate" system by lowering the top rates does not necessarily lead to a decrease of the progressivity of the rate structure. In fact the Belgian reforms have increased the rate progressivity substantially (the disproportionality index rises by 13%). The contribution of the tax scheme to the final liability progression has increased from 32% to 42%. Base broadening has pushed back the role of deductions slightly. But after the reforms the remaining deductions are a bit more disproportionately distributed in favour of higher income groups.

REFERENCES

- Atkinson A. B. and F. Bourguignon**, 1987. *Income Distribution and Differences in Needs*, in: Feiwel, (ed), *Arrow and the Foundations of the Theory of Economic Policy*, Basingstoke: Macmillan.
- Auerbach A.J. and J. Slemrod**, 1997. The Economic Effects of the Tax Reform Act of 1986, *Journal of Economic Literature*, 35(2), pp. 589-623.
- Ballentine J.G.**, 1986. The Short-Run Distributional Effect of Tax Reform, *Tax Notes*, 31(10), pp. 1035-39.
- Bishop J., J. Formby and B. Zheng**, 1998. Inference Tests for Gini-Based Tax Progressivity Indexes, *Journal of Business and Economics Statistics*, 16(3), pp. 322-330.
- Bishop J.A., K.V. Chow, J.P. Formby and C.-C. Ho**, 1997. Did Tax Reform Reduce Actual US Progressivity? Evidence from the Taxpayer Compliance Measurement Program, *International Tax and Public Finance*, 4, pp. 177-197.
- Coulter F.A.E., F.A. Cowell and S.P. Jenkins**, 1992. Equivalence Scale Relativities and the Extent of Inequality and Poverty, *Economic Journal*, 102, pp. 1067-1082.
- Decoster A. and G. Van Camp**, 2000. *The Unit of Analysis in Microsimulation Models for Personal Income Taxes: Fiscal Unit or Household?*, in Mitton, L., Sutherland, H., and Weeks, M., (eds.), *Microsimulation Modelling for Policy Analysis*, Cambridge: Cambridge University Press.
- Decoster A. and G. Van Camp**, 2001. Redistributive effects of the shift from personal income taxes to indirect taxes: Belgium 1988-93, *Fiscal Studies*, 22(1), pp. 79-106.
- Donaldson D. and J.A. Weymark**, 1980. A single-parameter generalization of the Gini indices of inequality, *Journal of Economic Theory*, 22, pp. 67-86.
- Duclos J-Y.**, 1997. The asymptotic distribution of linear indices of inequality, progressivity and redistribution, *Economics Letters*, 54, pp. 51-57.
- Feldstein M.**, 1988. Imputing Corporate Tax Liabilities to Individual Tax Taxpayers, *National Tax Journal*, 41(1), pp. 37-59.

Fellman J., 1976. The Effect of Transformations on Lorenz Curves, *Econometrica*, 44(4), pp. 823-824.

Fleurbaey M., C. Hagneré and A. Trannoy, forthcoming. Welfare Comparisons with Bounded Equivalence Scales, *Journal of Economic Theory*.

Formby J.P., Thistle P.D. and W.J. Smith, 1990. The Average Tax Burden and the Welfare Implications of Global Tax Progressivity, *Public Finance Quarterly*, 18, pp. 3-24.

Gelardi A.M.G., 1998. The effect of flattening tax brackets and converting deductions to credits on horizontal equity and progressivity: the case of the 1987 Canadian federal income tax reform, *Advances in Taxation*, 10, pp. 91-127.

Giles C. and P. Johnson, 1994. Tax Reform in the UK and Changes in the Progressivity of the Tax System, 1985-95, *Fiscal Studies*, 15(3), pp. 64-86.

Gramlich E. M., R. Kasten and F. Sammartino, 1993. Growing Inequality in the 1980s: the Role of Federal Taxes and Cash Transfers, in: Danziger, S. and Gottschalk, P., (eds), *Uneven Tides: Rising Inequality in America*, New York: Russell Sage Foundation.

Gravelle J.G., 1992. Equity Effects of the Tax Reform Act of 1986, *Journal of Economic Perspectives*, 6(1), pp. 27-44.

Jakobsson U., 1976. On the Measurement of the Degree of Progression, *Journal of Public Economics*, 5, pp. 161-68.

Jenkins S.P. and F.A. Cowell, 1994. Parametric Equivalence Scales and Scale Relativities, *Economic Journal*, 104, pp. 891-900.

Kasten R., F. Sammartino and E. Toder, 1994. Trends in Federal Tax Progressivity, 1980-93, in: Slemrod, J., (ed), *Tax Progressivity and Income Inequality*, Cambridge: Cambridge University Press.

Keen M., H. Papapanagos and A. Shorrocks, 2000. Tax Reform and Progressivity, *Economic Journal*, 110, pp. 50-68.

Lambert P., 2001. *The Distribution and Redistribution of Income*, third edition, Manchester: Manchester University Press.

- Lambert P. J. and X. Ramos**, 2002. Welfare comparisons: sequential procedures for heterogeneous populations, *Economica*, 69, pp. 549-562.
- Loizides I.**, 1988. The decomposition of progressivity indices with applications to the Greek taxation system, *Public Finance/Finances Publiques*, 43(2), pp. 236-247.
- McLure, C.E.Jr. and G.R. Zodrow**, 1987. Treasury I and the Tax Reform Act of 1986: The Economics and Politics of Tax Reform, *Journal of Economic Perspectives* 1(1), pp. 37-58.
- Ministerie van Financiën**, 1994. *Conjunctuurnota*, Brussel: Studie en Documentatiedienst van het Ministerie van Financiën.
- OECD**, 1990. *The Personal Income Tax Base: A Comparative Survey*, Paris: OECD.
- Palme M.**, 1996. Income Distribution Effects of the Swedish 1991 Tax Reform: An Analysis of a Microsimulation Using Generalized Kakwani Decomposition, *Journal of Policy Modelling*, 18(4), pp. 419-443.
- Pechman J.**, 1987. Tax Reform: Theory and Practice, *Journal of Economic Perspectives*, 1(1), pp. 11-28.
- Pechman J.**, 1990. The Future of the Income Tax, *American Economic Review*, 80(1), pp. 1-20.
- Pfähler W.**, 1987. Redistributive Effects of Tax Progressivity: Evaluating A General Class of Aggregate Measures, *Public Finance/Finances Publiques*, Vol. 42(1), pp. 1-30.
- Pfähler W.**, 1990. Redistributive Effect of Income Taxation: Decomposing Tax Base and Tax Rates effects, *Bulletin of Economic Research*, 42, pp. 121-129.
- Sastre M., and A. Trannoy**, 2002. Shapley inequality decomposition by factor components: Some methodological issues, in P. Moyes, C. Seidl and A.F. Shorrocks (Eds.), *Inequalities: Theory, Experiments and Applications*, *Journal of Economics*, Supplement 9, 51-90.
- Seidl C.**, 1994. Measurement of Tax Progressivity with Nonconstant Income Distributions, in: Eichhorn W., (ed), *Models and Measurement of Welfare and Inequality*, Berlin, Heidelberg, New York, Springer-Verlag.

Shorrocks A. F., 1982. Inequality decomposition by factor components, *Econometrica*, 50(1), pp. 193-211.

Shorrocks A. F., 1999. Decomposition Procedures for Distributional Analysis: A Unified Framework Based on the Shapley Value, *Working Paper*, University of Essex and Institute for Fiscal Studies.

Standaert I. en C. Valenduc, 1996. *Le Modèle de Microsimulation de l'Impôt des Personnes Physiques en Belgique: SIRE*, Research Paper nr 1, Brussel: Studie- en Documentatiedienst van het Ministerie van Financiën.

Standaert I. en C. Valenduc, 1998. Base de données sur les revenus des ménages? Modèle SIRE Prise en compte des revenus des ménages non-enrôlés, *mimeo*, Brussel: Studie en Documentatiedienst, Ministerie van Financiën.

Valenduc C., 1999. Les effets de la non-imposition des revenus de l'épargne, *Documentatieblad van het Ministerie van Financiën*, 59, nr. 4, pp. 211-236

Verbist G., 2002. An inquiry into the redistributive effect of personal income taxes in Belgium, *PhD*, Antwerpen: Departement Toegepaste Economische Wetenschappen, Universiteit Antwerpen.

Wagstaff A. and E. Van Doorslaer, 1997. *What Makes the Personal Income Tax Progressive? A Comparative Analysis for Fifteen OECD Countries*, working paper, Brighton: School of Social Sciences, University of Sussex.

Wagstaff A., E. Van Doorslaer, H. van der Burg, S. Calonge, T. Christiansen, G. Citoni, U.-G. Gerdtham, M. Gerfin, L. Gross, U. Häkinnen, J. John, P. Johnson, J. Klavus, C. Lachaud, J. Lauridsen, R. Leu, B. Nolan, E. Peran, C. Propper, F. Puffer, L. Rochaix, M. Rodriguez, M. Schellhorn, G. Sundberg and O. Winkelhake, 1999. Redistributive Effect, Progressivity and Differential Tax Treatment: Personal Income Taxes in Twelve OECD Countries, *Journal of Public Economics*, 72(1), pp. 73-98.

Yitzhaki S., 1983. On an Extension of the Gini Inequality Index, *International Economic Review*, 24(3), pp. 617-628.