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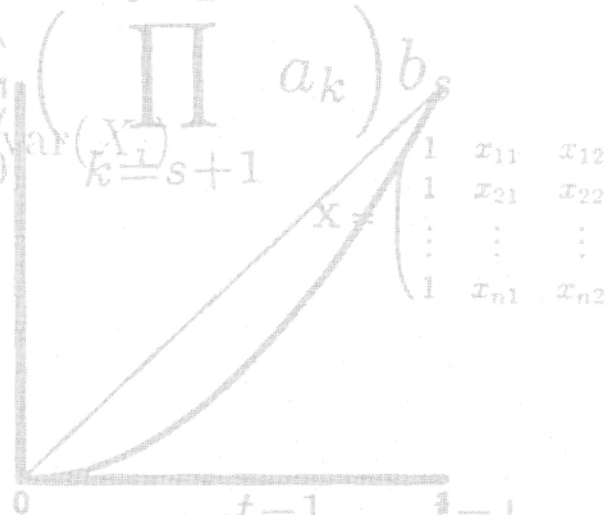
Thor Olav Thoresen

The Distributional Impact of the Norwegian Tax Reform Measured by Disproportionality

Discussion Papers

$$+ \frac{2}{dt} \sum_{i>j} \sum_{j=1} \text{COV}_{a_i} (X_i, X_j)$$

$$\text{var} \left(\sum_{i=1}^n a_i X_i \right) = \sum_{i=1}^n a_i^2 \text{var} (X_i) + \sum_{i=1}^{t-1} \sum_{s=0}^{t-1} \left(\prod_{k=s+1}^{t-1} a_k \right) b_s$$



$$\text{var} \left(\sum_{i=1}^n a_i X_i \right) = \sum_{i=1}^n a_i^2 \text{var} (X_i) + \sum_{i=1}^n \left(\prod_{k=s+1}^t a_k \right) \sum_{i=1}^n (y_i - (\hat{a}x_i + \hat{b}))$$

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Abstract:

This paper focuses on the measurement of progressivity and the distributional effect of the Norwegian tax reform of 1992. Progressivity is measured by the degree of disproportionality, which implies that the burden of taxes is estimated when income units are ranked according to pre-tax incomes. The measure of disproportionality is decomposed to estimate the influence from different parts of the tax system on total disproportionality. For instance, the measure of the contribution from net taxes can be decomposed into a tax base effect and a tax rate effect. The results show that the degree of progressivity in the overall tax system, as measured here, has not been altered from 1991 to 1992, but the decomposition analysis reveals that the tax base effect is more dominant and the tax rate effect is less dominant after the reform.

Keywords: Tax progressivity, Income distribution, Disproportionality in the tax burden, Tax reform, Decomposition of inequality

JEL classification: D31, D33, D63, H24

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1. Introduction

A conventional definition of a progressive tax system is that the average rate of tax is increasing with income. The progressivity of a tax system can, however, be described in several ways. There are two features of a progressive income tax system, known as disproportionality and its redistributive effect (Lambert 1993a). What divides them is the reranking of income units, which is necessary to compute the redistributive effect. Reranking means that income units change places in the ranking of incomes in the transition from pre-tax income to post-tax income. In the following the progressivity of the Norwegian tax system before and after a tax reform is measured by the degree of disproportionality. When measuring progressivity by disproportionality (in the tax burden), one examines to what extent the rich pay relatively more tax than the poor, when the income units are ranked according to pre-tax income. By limiting the analysis to evaluating the degree of disproportionality, I assert that evaluating taxes with reference to the pre-tax distribution is important, not at least in the governmental decision process to settle tax rates.

In section 5 the progressivity measure is presented and a method to decompose total disproportionality into effects from various parts of the tax system, e.g. gross taxes, net taxes, deductions, is also introduced. The decomposition of disproportionality is based upon the decomposition qualities of inequality measures and in section 4 the decomposition of the Gini coefficient is shown. There are important limitations to this approach, since total income is divided into components in a static and "accounting" way.

The methodological approach is demonstrated by employing income data for the year before and for the first year after the Norwegian tax reform of 1992. Pre-reform disproportionality is compared with post-reform disproportionality. The changes in the tax system in Norway during the last decade have mainly been based upon the same ideas as tax reforms in other European countries in recent years, involving a broadening of the tax base, reductions in tax rates on taxable net income and more tax on taxable gross income.¹

¹Note that income after tax is disposable income, while net income refers to taxable income after income deductions

The most significant changes in the Norwegian tax system were introduced in 1992. The alterations in the tax system are presented in section 2.

The nominal tax rate structure is progressive both before and after the reform with marginal tax rates increasing with income. To study nominal tax rates, based on different bands of gross and net income, has however only limited relevance. Measures of progressivity are defined in terms of the tax schedule and the pre-tax income distribution in which the tax schedule operates.

Unfortunately, very few conjectures about the effects of tax reforms can be deduced simply on theoretical basis. This is both due to the complexity of the tax system and behavioural effects. The intricacy of the Norwegian tax system can be elucidated by the number of variables involved, when actual taxes are calculated. For instance the individuals' family situation, socioeconomic status, deductions, income composition, etc., all influence tax payments. Thus, the concept of horizontal equity, implying that identical persons should be given an identical treatment (taxation), is troublesome in the case of taxes, because very few people are in a similar situation. Section 3 contains a brief discussion of the possibility of tax reform predictions and the interpretations of tax reforms in terms of welfare.

Economic theory predicts that individuals will adjust their behaviour to the new tax schedule. Some tax reforms are in fact motivated by the aspiration to influence peoples' decisions, for instance to increase labour supply. Behavioural responses to the Norwegian tax reform are not discussed in this study. The focus is on distributional effects without including any labour supply responses, i.e. so-called impact effects. Of course, when the pre-reform distribution of income is compared with the distribution of income a long time after the reform, people can be expected to have adjusted their labour supply, their saving, etc., according to the new tax system in work. In this study short term impact effects are observed, necessarily including any immediate responses to different changes, but not analysing these.

Nevertheless, some predictions can be made about the impact of the Norwegian tax

reform. For instance, when the tax base was extended to include profits earned on sales of shares in 1992, this would presumably lead to relatively larger taxable income for well-off income earners. When an income component, positively correlated with total income, is made taxable in a progressive tax system instead of being tax-free, this will, *ceteris paribus*, lead to more progressivity, measured by disproportionality.

However, there are reasons to call attention to a pure data problem, when evaluating tax reforms with data from income tax returns. When analyses of tax progressivity are built upon income tax returns data (the dominant approach e.g. in the Nordic countries), many tax-free incomes are not apparent in data before they are subject to taxation. Thus, a comparison of pre-reform progressivity and progressivity after the reform, might be misleading because important income components are only visible in the second year. An intertemporal comparison of tax progressivity might be biased if there are no corrections for artificial differences in pre-tax income.

A tax-benefit model might be the right tool to deal with data quality problems. Model calculations make it possible to employ different tax systems on the same data, to separate the effects from the new schedule alone. Thus, when analysing effects of tax reforms by using data from income tax returns, the ideal research strategy would be a combination of analyses of data for two different years and the use of a tax-benefit model to examine the effects from artificial differences in data. There are only small differences between the definitions of income from 1991 to 1992, and this study will only use the tax-benefit model in the comparison of samples of data for two different years, not employing any simulation techniques. The results are presented in section 7.

There is a whole range of different approaches to methods for distributional assessments. Non-income differences between households imply that one has to consider differences in needs, which leads to the question of use of equivalence scales. This issue is discussed in more detail in section 6.

2. The Norwegian tax reform of 1992

It was argued that the pre-reform Norwegian tax system was both inefficient and had adverse distributional effects (Norwegian Parliament 1990). It was generally believed that the new tax schedule will stimulate economic growth through a more neutral treatment of different investments and will give a more just tax system since it makes tax avoidance more difficult. The former tax system implied a highly progressive tax rate system, but did not give a corresponding distributional effect (Norwegian Parliament 1990). The widening of the tax base and a new tax rate structure was looked upon as a more efficient way to redistribute income.

Self-employed people were perhaps most affected by the reform. The income from their business was divided into yield of capital and yield of labour, which generally meant that a larger part of their income would be taxed as labour income, which is liable to heavier taxation than income from capital.

The main elements of the changes in the rate structure for 1992 are:

- A flat, proportional tax rate of 28 per cent on net taxable income, implying a reduction from the pre-reform top level of 40.5 per cent.
- An increase in the standard deduction for tax on net taxable income from 15 to 20 per cent of gross wages, salaries and pensions and an increase in the upper limit of this allowance from 10 000 to 27 000 NOK.
- An unchanged contribution rate to the National Insurance Scheme (part of tax on gross income) of 7.8 per cent for wage earners and self-employed farmers, fishermen and forestry workers. However, the contribution rate for other self-employed persons was reduced from 12.7 to 10.7 per cent, while for pensioners the contribution rate increased from 1.6 to 3 per cent.
- The introduction of the two-tiered top tax (tax on gross income). The first-tier tax rate is

the same as the pre-reform 9.5 per cent, but the second-tier tax rate was set at 13 per cent and levied on income above NOK 225 000 in class 1 and NOK 252 000 in class 2². The top marginal rate on employment income is thus reduced from 57.8 per cent for 1991 to 48.8 per cent for 1992.

Thus, even if the marginal tax rates were reduced, the progression of the tax system is achieved through an increase of standard deductions and a raise in taxes on gross income.

3. Definitions, predictions and interpretations

It is important to note that the term progression, as used here, refers to a property of the tax schedule alone, while progressivity is reserved for the interaction between the tax schedule and the pre-tax income distribution to which it is applied (Lambert 1993a). Hansen et al. (1992) present figures for both progression and progressivity for Norway in 1991 and the calculations are used to calculate a progressivity index. Figures for progression can be used to calculate measures of local progression (Musgrave and Thin 1948), as liability progression and residual progression. The difference between progression and progressivity can also be expressed by the difference between nominal and effective tax rates (see e.g. Atkinson and Stiglitz 1980, p. 29-30). The focus here is on a measure for progressivity and how it can be decomposed into contributions from different components of the tax system.

An income tax may be defined as progressive if a person with a higher income than another person pays a higher average rate of tax than the other. This definition is not entirely correct since the average tax payment is also a function of deductions, and different non-income characteristics such as family type, the socioeconomic status, the composition of income, etc. Another possibility is to define progression in terms of the tax liability for the same person at different income levels: Progression means that the average tax rate faced by an individual (or income unit) is increasing with income. This can be

²Married couples with one income and lone parents will normally pay tax according to class 2.

written as

$$(1) \quad \frac{d[t(x)/x]}{dx} > 0 \quad \text{for all } x$$

The definition above implies that the marginal tax rate must everywhere be larger than the average tax rate to make a tax system progressive. Essentially, the Norwegian tax system fulfils the requirement to a progressive tax system. It is piecewise linear with higher marginal tax rates on higher bands of income. This is not necessarily true if social security transfers, which are dependent on labour income, are included in the definition of progression. The "effective" marginal tax (for instance for lone mothers) might be very high in some income bands and might even contain nonlinear regions, when benefits are reduced because of labour income.

A tax reform implies that there is a new tax schedule at work and that people may in principle adjust their decisions to the new scheme.³ Thus, when comparing the effects of taxes in 1991 and 1992, both the pre-tax incomes and the nominal tax rates will be different. What predictions can be made about the effect of such a reform? And how can the results be interpreted in terms of welfare?

An important theorem by Jakobsson (1976) and Fellman (1976) confirms the following relationship between the Lorenz curves for post-tax income, pre-tax income and tax as long as the rate schedule is progressive, i.e. that the marginal tax rate exceeds the average tax rate on every income level:

$$(2) \quad L_{X-T} \geq L_X \geq L_T$$

³Not everyone has flexibility to vary their hours of work though

where $X-T$ is post-tax income, X is pre-tax income and T is tax. The distribution of post-tax income is more equal than the distribution of pre-tax income, since taxes are more unequally distributed than pre-tax incomes. It is assumed that no income unit experiences negative marginal tax rates or marginal tax rates above 100 per cent. Since the tax rate schedules are progressive both before and after the reform, one expects to find tax progressivity both in the income distribution for 1991 and the income distribution for 1992. Most other conjectures about the effects of tax reforms are either built on equiproportionate growth of pre-tax incomes or an unrealistic relationship between average tax rates and marginal tax rates (i.e. about measures of local progression) and are less applicable in real-world situations (see e.g. Lambert and Pfähler 1992).

Any comparison of different income distributions in terms of welfare involves both the question of levels of income and how the income is divided between income units. Two different situations are both characterized by the size of the cake and the division of the cake. Thus, the evaluation of effects of tax reforms might embody a trade-off between real income growth and "pure" distributional matters. One way to handle this problem is to employ generalized Lorenz curves (Shorrocks 1983). The generalized Lorenz curve is a criterion for social welfare in terms of mean incomes and Lorenz curves. As shown by Kakwani (1984), generalized Lorenz dominance can successfully conclude many pairwise comparisons of countries, but not all.

In this analysis the focus is on distributional aspects, without considering the size of the cake before and after the reform. In the generalized Lorenz curve approach, taxation reduces social welfare unambiguously (Lambert 1993a), which is reasonable when government spending is not included in the social welfare function. The question of the cost of the tax burden taxation is, however, extremely difficult and the trade-off between efficiency and equity is usually better explained by other methodological approaches, for instance by general equilibrium models. There are, thus, good reasons to focus only on the distribution of the tax burden in two different situations, without bringing any comprehensive examination of the welfare implications of taxation into consideration.

This does not mean that the analyses have no normative contents. Using an index of

relative inequality, like the Gini coefficient, implies some notion of an interpersonal comparability function and, thus, there are normative judgements involved in the aggregation. In fact, the approach can be thought of as resulting from social welfare functions (Dalton 1920, Atkinson 1970, Blackorby and Donaldson 1978). However, it is important to note that we sum over individual income or equivalent income, as income is assumed to be an indicator of well-being. We do not sum over individual utility functions or individual expenditures. In terms of Sen (1973) the income-distributional comparisons are regarded as "non-compulsive judgements", which means that there are good reasons for the analytical approach chosen, but there might be significant arguments contrary to the results we produce. For instance, the general perception of inequality in a society might be different from the degree of inequality aversion embodied in the Gini coefficient.⁴ Appendix A describes how the generalized Gini coefficient can be decomposed, to examine how the results are sensitive to the degree of inequality aversion chosen.

As will be shown in section 5 below, there is a close relationship between inequality and progressivity, and progressivity measures may be given the same interpretation as the inequality measures, in terms of social evaluation.

4. The decomposition of the Gini coefficient

A single measure for progressivity will only give information about the change in inequality after the reform, without any specific reference to the new tax schedule in work. A simple comparison of pre-tax and post-tax incomes is not sufficient to uncover the consequences of governmental activity on taxes and redistribution (Kakwani 1977a, Pfähler 1990). The decomposition of total disproportionality implies therefore additional information about the functioning of the tax system.

When decomposing total disproportionality we apply the decomposibility properties of the Gini coefficient. As demonstrated by Rao (1969), Kakwani (1977b) and Aaberge (1986)

⁴ On properties of the Gini coefficient consult Aaberge (1993).

the Gini coefficient can be decomposed. The analyses are based on one specific inequality measure. Appendix A describes how the analyses can be extended by applying the generalized Gini family of inequality measures (or the extended Gini coefficient) (Yitzhaki 1983).

It is assumed that total income, X , is the sum of n different factors, X_i

$$(3) \quad X = \sum_{i=1}^n X_i$$

The relation between the Gini coefficient and the income components' contribution to inequality is given by the following expression,

$$(4) \quad G = \sum_{i=1}^n \frac{\mu_i}{\mu} \gamma_i$$

where μ_i/μ is the ratio between the means of X_i and X , respectively, and γ_i can be interpreted as the conditional Gini-inequality of factor i given the units rank order in X . γ_i is called a concentration coefficient and measures average correlation between factor i and total income, conditional on the income units ranked in order of total income. If γ_i is equal to zero, then every household receives an equal amount of factor i and the factor has a neutral effect. If factor i is positive ($\mu_i > 0$), then $\gamma_i > 0$ means that the upper part of the distribution on average receives more of the income factor than the lower parts.

This methodology will be used to evaluate the effect of the Norwegian tax reform of 1992 on disproportionality and trace the influences from different parts of the tax system, when the income units are ranked according to the pre-tax income. There are, however, reasons to emphasise the limitations of such an approach. As pointed out by Lambert and Pfähler (1992) and Aaberge and Aslaksen (1995) there are important interdependencies in the

components, which limits the interpretations of decomposition analyses. Nevertheless, we find this decomposition methodology useful when evaluating the effects of a tax reform. It gives information about how the different parts of the tax system "hit" the distribution of pre-tax incomes.

5. Measurement of tax progressivity

Following Lambert (1993b) there are two approaches to trace the influence from taxes, making a distinction between redistributive effects and disproportionality. The two approaches to progressivity are closely related to each other. First, the redistributive effect, perhaps the most obvious way to evaluate the effect of a tax reform, is measured by a comparison of inequality in pre-reform distributions with inequality post-reform distributions. This approach was used by Musgrave and Thin (1948) to focus on a single measure of progressivity. In Strøm et al. (1993) the same methodology is used to describe the redistributive effect of the Norwegian tax system. Thus, the redistributive effect is defined by

$$(5) \quad R = G_X - G_Y,$$

where disposable income or post-tax income (Y) is pre-tax income (X) minus taxes (T). G refers to the Gini coefficient. This is simply a comparison of the degree of inequality in the distribution of post-tax income and the degree of inequality in pre-tax income and says nothing about whether or how pre-tax income units are reranked by introducing the tax-schedule.

The second approach describes the relation between pre-tax income and the tax burden, when income units are ranked according to pre-tax income and implies the use of concentration coefficients. The following index measures the degree of disproportionality in the tax system (Kakwani 1977a):

$$(6) \quad D = \gamma_T - G_X,$$

where γ_T is the concentration coefficient for taxes (see section 4 for a interpretation of concentration coefficients). A proportional tax levied upon all income units, will give $D=0$ in the equation above. The introduction of progression (taxes are increasing in income) implies that in order to get the same revenue as with a proportional system, income must be transferred from rich to poor. Hence, disproportionality is a sign of progressivity.

The two measures of progressivity are related (Lambert 1993b) and the fundamental difference between D and R is the reranking of income units by the redistributive measure. Reranking means that income units change places in the ranking of incomes in the transition from ranking of pre-tax income to ranking of post-tax income because of taxation. Reranking of income units according to taxes is by some authors proposed as a measure of horizontal inequity and an indication of an unfair tax system. Plotnick (1981) estimates the degree of reranking or horizontal inequity as

$$(7) \quad P = G_Y - \gamma_Y,$$

which is a comparison of the Gini coefficient for post-tax income and the concentration coefficient for post-tax income, when the incomes are ranked according to pre-tax income. Kakwani (1984) demonstrates that there is a link between income tax progressivity measured by the redistributive effect (equation 5) and progressivity measured by disproportionality (equation 6), using Plotnick's measure:

$$(8) \quad R = [g/(1-g)]D - P,$$

where $g = \mu_T/\mu_X$. (8) can be written as

$$(9) \quad G_X - G_Y = \frac{\mu_T}{\mu_Y} (\gamma_T - G_X) - (G_Y - \gamma_Y).$$

Equations (8) and (9) illustrate that the redistributive effect consists of the disproportionality measure multiplied with the average tax level ratio and an index for reranking correction. Many empirical studies have ignored the effect from reranking when analysing redistributive progressivity (Lambert 1993a). But excluding reranking when calculating the redistributive effect is generally misleading, as displayed by the equations above, and may lead to biases in the estimates of progressivity measured by the redistributive effect (see e.g. Jenkins 1988).

By focusing on progressivity measured by the distribution of the tax burden, the progressivity measure involves just one ranking of income, since incomes are ranked according to the pre-tax income distribution only. The index

$$(10) \quad \gamma_T - G_X = \frac{\mu_Y}{\mu_T} (G_X - \gamma_Y)$$

expresses disproportionality in terms of a tax level ratio and inequality measures. This relation can also be derived from equation (9) above by eliminating the measure for post-tax inequality on both sides of the equation. This results in only one ranking of incomes, and the redistributive measure of progressivity is transformed to an index for disproportionality. Disproportionality is here seen as a function of the general tax level and a measure for the relationship between total inequality in pre-tax income and the

concentration coefficient for post-tax income. Hence, the progressivity measure can be expressed as dependent on the actual proportion of the tax burden and the relation between inequality measures. Progressivity measured by disproportionality increases when the difference between and inequality in pre-tax income and the concentration coefficient for disposable income increases, and increases when tax enlarges its share in gross income. A proportional tax system implies that $\gamma_T = G_X$.⁵

Pfähler (1990) introduces some decomposition formulae for the redistributive effect, to break down the different influencing factors within a tax system. In Pfähler's approach the total redistributive effect ($G_X - G_Y$) is decomposed into tax base and tax rates components without bringing reranking into consideration. Instead of decomposing the redistributive effect, the same kind of methodology will here be used to identify different factors' contribution to disproportionality. Pfähler (1990) does not explicitly bring tax on gross income into his scheme of analysis. But tax on gross income has become an important part of the Norwegian tax revenue and both the effect from tax on net income and tax on gross income will be isolated. This methodology will give a better understanding of the influence from the different parts of the tax system on the final result. It must be emphasised that the way total disproportionality is decomposed here, is only one of several possibilities. The measures developed here can also be further decomposed.

We introduce the following terms and relations, partly from Pfähler (1990):

- gross income, X
- tax-free income (mainly tax-free income transfers), A
- income deductions, D
- total tax-free income when calculating tax on net income, $F = A+D$
- disposable income, Y
- residual disposable income, $YI=Y-A$
- tax on net income, NT
- tax on gross income, GT

⁵ Remember that both γ_T and G_X are indices and only give average figures, which in this context means that a tax system may have progressive or regressive parts even if $\gamma_T = G_X$.

- total tax, $T=GT+NT$
- taxable gross income, $XI=X-A$
- residual income, $RI=XI-NT$
- taxable net income, $TNI= X-F=XI-D$
- residual net income, $RNI=TNI-NT$
- disposable income, $Y=X-T=F+TNI$

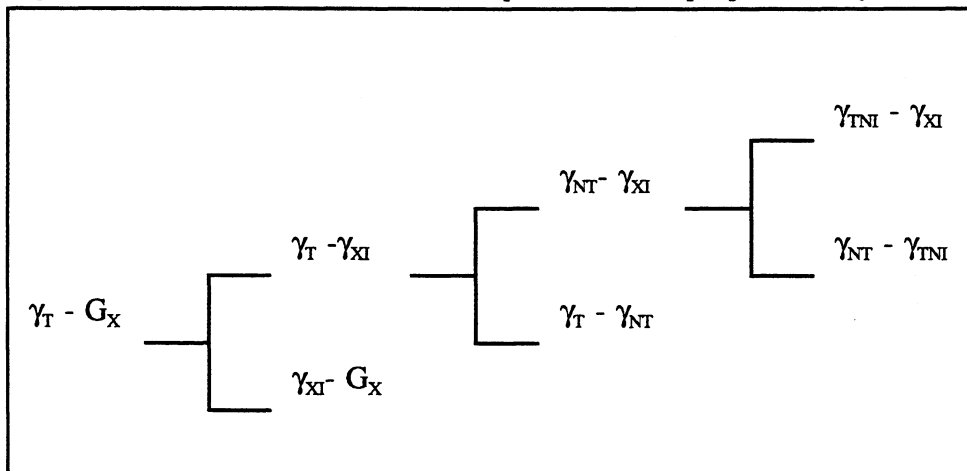
In figure 1 the same relations and terms are shown in a diagram.

Figure 1. The decomposition of gross income into income components.

X	A	A	A	Y	A	F
	XI	RI	YI		D	
			GT	T	RNI	TNI
		NT	NT	NT		

By separating different parts of gross income, one can calculate the contribution from various taxes, income deductions and tax-free incomes to overall disproportionality. The measure $(\gamma_T - G_X)$ is decomposed into various effects in steps shown by figure 2. For instance, the first step is obtained by rewriting (10), $(\gamma_T - G_X) = (\gamma_T - \gamma_{XI}) + (\gamma_{XI} - G_X)$. In this step the effect on total progressivity from the distribution of tax-free income is separated. Included in tax-free income are child benefits, special housing allowances and parts of social security benefits.

Figure 2. An overview over the decomposition of disproportionality



It can be shown that a measure of the contribution from tax-free incomes to total disproportionality can be derived by the following decomposition of total disproportionality

$$(11) \quad \gamma_T - \gamma_{XI} = \frac{\mu_{YI}}{\mu_T} (\gamma_{XI} - \gamma_{YI})$$

and

$$(12) \quad \gamma_{XI} - G_X = \frac{\mu_A}{\mu_{XI}} (G_X - \gamma_A)$$

(11) and (12) display the division of the overall measure for progressivity into effects from taxes and effects from tax free-free income components. (12) demonstrates that the effect from tax-free income on progressivity depends on a tax-free income ratio and the difference between the total inequality and the concentration coefficient for tax-free income. If the tax-free income concentration coefficient is larger than total inequality, (12) shows that the contribution from this income factor will lead to regressivity. (11) yields a

measure for tax progressivity when tax-free income components are deducted from total income. By adding (11) and (12), (13) is derived, which displays that total disproportionality can be seen as a result of effects from taxes and tax-free incomes.

$$(13) \quad \gamma_T - G_X = \frac{\mu_A}{\mu_{XI}} (G_X - \gamma_A) + \frac{\mu_{YI}}{\mu_T} (\gamma_{XI} - \gamma_{YI})$$

In the following it will be shown how $(\gamma_T - \gamma_{XI})$ (equation 11) can be further decomposed into effects from tax on gross income and tax on net income and how the tax on net income can be decomposed into effects from deductions and tax rates. A decomposition of (11) yields the following equations for the influences from tax on gross income and tax net income:

$$(14) \quad \gamma_{NT} - \gamma_{XI} = \frac{\mu_{RI}}{\mu_{NT}} (\gamma_{XI} - \gamma_{RI})$$

and

$$(15) \quad \gamma_T - \gamma_{NT} = \frac{\mu_{GT}}{\mu_T} (\gamma_{GT} - \gamma_{NT})$$

(14) measures the impact of tax on net income. It consists of a net tax ratio and the relation between the concentration coefficient for taxable gross income and the concentration coefficient for residual income. Residual income is the part of taxable gross income that does not end as net tax (confer figure 1 above). If the concentration coefficient for taxable gross income (γ_{XI}) is large compared to the concentration coefficient for residual income (γ_{RI}), the net taxes will contribute positively to the degree

of progressivity. (15) provides an expression for the impact on progressivity from tax on gross income. This relation is different from the others. The contribution from taxation of gross income is measured relatively to the contribution from taxes on net income. In effect, (15) expresses how the existence of tax on gross income influences on total disproportionality in relation to the impact from net taxes. Hence, $(\gamma_T - \gamma_{NT})$ will be negative or positive, dependent on how the distribution of gross tax is in relation to the distribution of net tax. The relative gross tax contribution is a product of the ratio of gross tax to total tax and the relation between concentration coefficients for tax on gross income and tax on net income. It follows from the decomposition procedure employed here that gross taxes have a positive effect on disproportionality relative to the effect from net taxes, if γ_{GT} is larger than γ_{NT} .

Equation (14) can be further decomposed into a "tax rate effect" and a "tax base effect", as follows:

$$(16) \quad \gamma_{TNI} - \gamma_{XI} = \frac{\mu_D}{\mu_{TNI}} (\gamma_{XI} - \gamma_D)$$

and

$$(17) \quad \gamma_{NT} - \gamma_{TNI} = \frac{\mu_{RNI}}{\mu_{NT}} (\gamma_{TNI} - \gamma_{RNI})$$

The rate effect of net taxes is a product of a tax level effect (μ_{RNI}/μ_{NT}) and the difference between the relationship between taxable income and residual net income. The size of γ_{RNI} depends on how much of the taxable income that ends as tax payments in different parts of the distribution and therefore (16) can be interpreted as displaying the tax rate structure of net income taxation. The base effect of the tax on net income arises from the structure and distribution of tax deductions. Equation (17) shows that a large positive concentration

coefficient for deductions, which means that the richest have the largest deductions, gives a progressivity reducing effect. Combining (16) and (17) gives the tax on net income progressivity as a weighted sum of the tax rate effect and the tax base effect, as shown by equation (18):

$$(18) \quad \gamma_{NT} - \gamma_{XI} = \frac{\mu_{RNI}}{\mu_{NT}}(\gamma_{TNI} - \gamma_{RNI}) + \frac{\mu_D}{\mu_{TNI}}(\gamma_{XI} - \gamma_D).$$

This completes the decomposition of disproportionality. Generally, the way a measure is decomposed and how far the decomposition goes, hinges on the problem addressed. It is important to note that total income is divided into components in an "accounting" procedure, and that there are important interdependencies between the indices. It is also worth noting that the relation between net taxes and gross taxes is in the decomposition procedure is different than the other stages in the approach, since the influence from gross taxes is measured relatively to the impact of net taxes. In section 7 below, this scheme will be used to demonstrate changes in the distribution of the tax burden after the Norwegian tax reform of 1992.

6. Unit of analysis and equivalent income

Analyses of inequality and evaluation of income distributions also involve the question of methodological approaches to the interpersonal comparison issue. In the following we will simply assume that persons with the same income are equally well-off. Due to the strong economical link between members of the same household, the household is our unit of analysis. Persons belonging to the same household are dependent on each others resources and even if the data permit studies based on individual incomes, the analyses are founded on the households' aggregated incomes. Thus, it is implicitly assumed that each member of the household is equally well-off. As income is measured on the household level, comparable income must be defined. This is a complicated issue with no widespread consensus (see, e.g. Coulter et al. 1992a). One approach involves comparisons of income in money terms for homogeneous groups, but in the following we will apply we employ a

common metric to compare the well-being of household members of different households of different size.

According to Buhmann et al. (1988) a simple characterisation of the equivalence scale is given by

$$(19) \quad M_s = s^\theta$$

where s refers to the household size.⁶ The equivalence scale elasticity, θ , varies between zero and one. $\theta=0$ implies no adjustment for needs, $\theta=1$ implies income per person. The larger it is, the smaller are the economies of scale assumed by the equivalence scale. When focusing on the dependency between the size of the household and welfare, we highlight the size of the households' influence on welfare. In fact, other characteristics, as age, location, health of members, etc., generally affect the scales. But Buhmann et al. (1988) demonstrate that (19) is a good approximation to most scales currently in use. By using this approach to household comparability, we are to some extent, able to check the sensitivity of choice of equivalence scales on our results. Glewwe (1991) demonstrates that the application of equivalence scales implies efficiency differences in the utilisation of income between households, which may lead to counterintuitive results. There has been a recent exchange of views in *Economic Journal* between Jenkins and Cowell (1994) and Banks and Johnson (1994) about fitting a 2-parameter extension of Buhmann et al. to UK.

The calculations are made on basis of distributions with same weight on each person, irrespective of the size of the family to whom they belong (Danziger and Taussig 1979, Sen 1979).

7. Results

⁶ See Coulter et al. (1992b) for a discussion of the relation between inequality measures and equivalence scales relativities.

Table 1 presents estimates for disproportionality for 1991 and 1992 when equivalent income is defined as income divided by the square root of number of household members, i.e. $\theta=0.5$. The calculations are done by using a tax-benefit model with data for 1991 and 1992. The different estimates in the table relate to the measure for total disproportionality and measures for the influences from different parts of the tax system, as demonstrated in section 5. Table B.1 and table B.2 in appendix B contain similar estimates for different assumptions about the degree of economies of scale in the households. The tables in appendix B confirm that the estimates are dependent on choice of equivalence scales, but the dependency in 1991 is similar to the dependency in 1992.

Table 1. Estimates of total disproportionality and the contribution from different parts of the tax system for 1991 and 1992. Average figures are in Norwegian kroner. $\theta=0.5$

	1991	1992
$\gamma_T - G_X = \mu_Y/\mu_T (G_X - \gamma_Y)$	0.140 = 0.414 - 0.274 = 147499/46843 (0.274 - 0.229)	0.138 = 0.418 - 0.280 = 155846/45468 (0.280 - 0.239)
$\gamma_T - \gamma_{XI} = \mu_{YI}/\mu_T (\gamma_{XI} - \gamma_{YI})$	0.122 = 0.414 - 0.292 = 139578/46843 (0.292 - 0.251)	0.120 = 0.418 - 0.298 = 148062/45468 (0.298 - 0.261)
$\gamma_{XI} - G_X = \mu_A/\mu_{XI} (G_X - \gamma_A)$	0.018 = 0.292 - 0.274 = 7921/186421 (0.274 - (-0.155))	0.018 = 0.298 - 0.280 = 7784/193530 (0.280 - (-0.172))
$\gamma_{NT} - \gamma_{XI} = \mu_{RI}/\mu_{NT} (\gamma_{XI} - \gamma_{RI})$	0.125 = 0.417 - 0.292 = 155042/31379 (0.292 - 0.267)	0.125 = 0.423 - 0.298 = 164828/28702 (0.298 - 0.276)
$\gamma_T - \gamma_{NT} = \mu_{GT}/\mu_T (\gamma_{GT} - \gamma_{NT})$	-0.003 = 0.414 - 0.417 = 15464/46843 (0.407 - 0.417)	-0.005 = 0.418 - 0.423 = 16766/45468 (0.411 - 0.417)
$\gamma_{NT} - \gamma_{TNI} = \mu_{RNI}/\mu_{NT} (\gamma_{TNI} - \gamma_{RNI})$	0.101 = 0.417 - 0.316 = 102718/31379 (0.316 - 0.285)	0.089 = 0.423 - 0.334 = 103243/28702 (0.334 - 0.310)
$\gamma_{TNI} - \gamma_{XI} = \mu_D/\mu_{TNI} (\gamma_{XI} - \gamma_D)$	0.024 = 0.316 - 0.292 = 52324/121038 (0.292 - 0.231)	0.036 = 0.334 - 0.298 = 61585/131954 (0.298 - 0.220)

Table 1 shows that there is no difference between the tax progressivity in 1991 and 1992.

$(\gamma_T - G_X)_{1991}$ is 0.140 while $(\gamma_T - G_X)_{1992}$ is 0.138 and the difference is not statistically significant.⁷ The inequality in pre-tax income is higher in 1992 than in 1991. But since taxes also are more unequally distributed, the tax progressivity measured by disproportionality is more or less the same in 1992 as in 1991.

To demonstrate how the different parts of the tax system contribute to the results in 1991 and 1992, table 2 presents estimates of the impact of tax-free income and taxes for 1991 and 1992, expressed in shares of total disproportionality in per cent for each year. The influence from taxes and tax-free income components has not changed from 1991 to 1992. This result is independent of choice of equivalence scale, consult tables in appendix B. The actual percentage in each year varies according to the assumptions about the degree of economies of scale, mainly because of sensitivity of several tax-free transfers to the choice of scale. For instance, the distributional impact of the child benefit is strongly influenced by the assumptions about the degree of economies of scale.

Table 2. Estimates of the contribution from taxes and tax-free income to total disproportionality for 1991 and 1992. $\theta=0.5$

Total disproportionality	Decomposition	1991	1992
$\gamma_T - G_X$	Tax effect $\gamma_T - \gamma_{XI}$	87%	87%
	Tax-free income effect $\gamma_{XI} - G_X$	13%	13%

As revealed in section 5, the relation between tax on gross income and tax on net income in the decomposition procedure is different from the other decomposition formulations. In table 3 the relation between net taxes and gross taxes is illustrated by an estimate of the relative impact of gross taxes in addition to the progressivity already embodied in net taxes' contribution to disproportionality. Equation (15) in section 5 above, displays that a

⁷Since calculations are done by a tax-benefit model based upon samples of income tax returns, statistical variation must be brought into consideration. The standard errors have been calculated and as a rule of thumb the standard error is around 0.003.

positive contribution from gross taxes is conditional on γ_{GT} being larger than γ_{NT} .

Table 3. Estimates of the impact of taxes on gross income in relation to the impact of taxes on net income for 1991 and 1992. $\theta=0.5$

	1991	1992
$(\gamma_T - \gamma_{NT})/(\gamma_{NT} - \gamma_{XI})$	-2%	-4%

Table 3 shows that the influence from taxes on total disproportionality would have increased by 2 per cent and 4 per cent, respectively for 1991 and 1992, if all taxation had been imposed in the form of tax on net income. It is important to note that several deductions in taxes are arbitrarily deducted from net taxes in the accounting system followed here. Among them is the special tax deduction for pensioners with low income or limited taxable capacity, which obviously has a progressive effect. Thus, the relation between the distributional impact of net taxes and gross taxes is to some extent influenced by the arbitrarily categorisation of tax deductions.

Most important, the results show no reduction in the negative influence from gross taxes after the reform. This is perhaps surprising, since the tax reform involved the introduction of the two-tiered tax on higher gross incomes (see section 2). However, the results indicate that the increase in the standard deductions has maintained the progressivity of net taxes, in spite of the introduction of a flat proportional tax. There are reasons to believe that the reduction in the contribution rate to the National Insurance Scheme for self-employed persons and the increase in the contribution rate for pensioners after the reform has contributed to less progressivity in gross taxes. It is also worth noting that the special tax deduction for pensioners with low income made a larger impact in 1992 than in 1991. Further decomposition of the effect from taxes on gross income would have given additional information about the different factors behind this result.

A further decomposition of the influences from net taxes, yields measures for the net tax rate effect and the net tax base effect. In table 4 the estimates of these measures are presented. The tax reform involved a substantial increase in the standard deduction and a

flat proportional net tax rate instead of the pre-reform progressive tax rate system, which has given a larger tax base effect and a smaller tax rate effect in 1992 compared to 1991. This result is also independent of choice of equivalence scale.

Table 4. Estimates of contribution from the tax rate effects and the tax base effects to the influence on disproportionality from net taxes for 1991 and 1992. $\theta=0.5$

Measure for contribution to disproportionality from net taxes	Decomposition	1991	1992
$\gamma_{NT} - \gamma_{XI}$	Net tax rate effect $\gamma_{NT} - \gamma_{TNI}$	81%	71%
	Net tax base effect $\gamma_{TNI} - \gamma_{XI}$	19%	29%

8. Conclusion

This paper has focused on progressivity in terms of disproportionality in the tax burden and it is shown how the measure of disproportionality can be decomposed. When using this scheme in the evaluation of the distributional impact of the Norwegian tax reform of 1992, it is found that the degree of total disproportionality is unaltered by the reform. There are no substantial changes in the contribution from tax-free incomes, gross taxes and net taxes. The decomposition of the influence from net taxes, displays that the tax base effect is more dominant, and accordingly, the tax rate effect is less dominant after the reform. This can be explained by the introduction of a flat proportional tax rate on net income, combined with a substantial increase in the standard deduction.

Further research on progressivity and the Norwegian tax reform should also employ other measures of progressivity, such as the measure of the redistributive effect. The redistributive effect involves an index for reranking correction in addition to the measure of disproportionality. It raises the question of horizontal inequity effects of the tax reform, which is an important additional perspective.

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Appendix A

Yitzhaki (1983) has suggested the following generalization of the Gini coefficient

$$(A.1) \quad G(v) = 1 - v(v-1) \int_0^1 (1-u)^{v-2} L(u) du$$

where v is a parameter describing the weight placed on the lowest part of the distribution. There is one generalized Gini coefficient for each real number $v \geq 1$, and $v=2$ defines the ordinary Gini coefficient. A high value of v means more focus on the lowest incomes in the distribution.

We can also define the generalized Gini coefficient in terms of a parametrically weighted Lorenz area by using covariances (Lambert 1993b):

$$(A.2) \quad G(v) = -v \cdot \text{cov}(X_i, [1 - F(X_i)]^{v-1}) / \mu_X$$

where μ_X is the average of total income, X . The distribution function $F(X_i)$ defines the rank of observation X_i . The poorest income unit has rank $1/N$, the richest has rank 1.

In order to present national figures, weighted observations are used in the analyses of disproportionality. The estimation of the generalized Gini coefficient, when employing a weighted data material, is given by Lerman and Yitzhaki (1989). The distribution function and the covariance in a weighted sample are given by the following terms, respectively:

$$(A.3) \quad \hat{F}_i(X) = \sum_{j=0}^{i-1} w_j + \frac{w_i}{2}$$

where $w_0 = 0$ and

$$(A.4) \quad \text{cov}(X, [1 - F(X)]^{\nu-1}) = \sum_{i=1}^n w_i (X_i - \mu_X) [(1 - \hat{F}_i)^{\nu-1} - m]$$

where

$$(A.5) \quad m = \sum w_i (1 - \hat{F}_i)^{\nu-1}$$

Moreover, the concentration coefficient for an income factor can be estimated by a similar procedure as above. For disposable income the relation is

$$(A.6) \quad \gamma_Y(\nu) = -\nu \cdot \text{cov}(Y, [1 - F_X(X)]^{\nu-1}) / \mu_Y$$

where

$$(A.7) \quad \text{cov}(Y, [1 - F_X(X)]^{\nu-1}) = \sum_{i=1}^n w_i (Y_i - \mu_Y) [(1 - \hat{F}_i)^{\nu-1} - m]$$

Appendix B

Table B.1 and table B.2 present measures for disproportionality with different assumptions about the degree of economies of scale in the households. B.1 and B.2 display measures for 1991 and 1992, respectively.

Table B.1. Estimates of measures of disproportionality with different assumptions about the degree of economies of scale. 1991

	$\theta=0.0$	$\theta=0.2$	$\theta=0.4$	$\theta=0.6$	$\theta=0.8$	$\theta=1.0$
μ_Y/μ_T	3.146	3.146	3.147	3.151	3.155	3.162
$(G_X - \gamma_Y)$	0.034	0.039	0.043	0.046	0.046	0.044
$\gamma_T - G_X = \mu_Y/\mu_T (G_X - \gamma_Y)$	0.108	0.122	0.135	0.143	0.145	0.139
μ_{YI}/μ_T	2.959	2.966	2.975	2.985	2.997	3.010
$(\gamma_{XI} - \gamma_{YI})$	0.033	0.036	0.034	0.042	0.041	0.039
$\gamma_T - \gamma_{XI} = \mu_{YI}/\mu_T (\gamma_{XI} - \gamma_{YI})$	0.097	0.108	0.118	0.124	0.124	0.117
μ_A/μ_{XI}	0.047	0.045	0.043	0.042	0.040	0.038
$(G_X - \gamma_A)$	0.245	0.323	0.389	0.467	0.531	0.571
$\gamma_{XI} - G_X = \mu_A/\mu_{XI} (G_X - \gamma_A)$	0.012	0.015	0.017	0.019	0.021	0.022
μ_{RI}/μ_{NT}	4.938	4.937	4.939	4.949	4.949	4.956
$(\gamma_{XI} - \gamma_{RI})$	0.019	0.022	0.024	0.026	0.027	0.026
$\gamma_{NT} - \gamma_{XI} = \mu_{RI}/\mu_{NT} (\gamma_{XI} - \gamma_{RI})$	0.096	0.108	0.120	0.128	0.131	0.127
μ_{GT}/μ_T	0.333	0.332	0.331	0.330	0.328	0.327
$(\gamma_{GT} - \gamma_{NT})$	0.003	-0.001	-0.006	-0.014	-0.022	-0.028
$\gamma_T - \gamma_{NT} = \mu_{GT}/\mu_T (\gamma_{GT} - \gamma_{NT})$	0.001	-0.000	-0.002	-0.005	-0.007	-0.009
μ_{RNI}/μ_{NT}	3.260	3.265	3.271	3.277	3.283	3.290
$(\gamma_{TNI} - \gamma_{RNI})$	0.025	0.028	0.030	0.032	0.032	0.030
$\gamma_{NT} - \gamma_{TNI} = \mu_{RNI}/\mu_{NT} (\gamma_{TNI} - \gamma_{RNI})$	0.081	0.090	0.098	0.103	0.104	0.100
μ_D/μ_{TNI}	0.394	0.392	0.391	0.390	0.389	0.388
$(\gamma_{XI} - \gamma_D)$	0.037	0.047	0.056	0.065	0.069	0.069
$\gamma_{TNI} - \gamma_{XI} = \mu_D/\mu_{TNI} (\gamma_{XI} - \gamma_D)$	0.015	0.018	0.022	0.025	0.027	0.027

Table B.2. Estimates of measures of disproportionality with different assumptions about the degree of economies of scale. 1992

	$\theta=0$ 0	$\theta=0.2$	$\theta=0.4$	$\theta=0.6$	$\theta=0.8$	$\theta=1$ 0
μ_Y/μ_T	3.409	3.415	3.423	3.433	3.446	3.460
$(G_X - \gamma_Y)$	0.032	0.036	0.039	0.041	0.041	0.039
$\gamma_T - G_X = \mu_Y/\mu_T (G_X - \gamma_Y)$	0.109	0.122	0.134	0.142	0.143	0.135
μ_{YI}/μ_T	3.217	3.231	3.247	3.266	3.287	3.309
$(\gamma_{XI} - \gamma_{YI})$	0.030	0.034	0.036	0.038	0.037	0.026
$\gamma_T - \gamma_{XI} = \mu_{YI}/\mu_T (\gamma_{XI} - \gamma_{YI})$	0.098	0.108	0.117	0.123	0.122	0.086
μ_A/μ_{XI}	0.046	0.043	0.041	0.039	0.037	0.035
$(G_X - \gamma_A)$	0.256	0.327	0.409	0.492	0.564	0.612
$\gamma_{XI} - G_X = \mu_A/\mu_{XI} (G_X - \gamma_A)$	0.012	0.014	0.017	0.019	0.021	0.022
μ_{RI}/μ_{NT}	5.710	5.721	5.735	5.752	5.771	5.794
$(\gamma_{XI} - \gamma_{RI})$	0.017	0.019	0.021	0.022	0.023	0.013
$\gamma_{NT} - \gamma_{XI} = \mu_{RI}/\mu_{NT} (\gamma_{XI} - \gamma_{RI})$	0.096	0.108	0.120	0.129	0.131	0.127
μ_{GT}/μ_T	0.372	0.371	0.370	0.368	0.367	0.366
$(\gamma_{GT} - \gamma_{NT})$	0.004	- 0.000	- 0.007	- 0.016	- 0.027	- 0.035
$\gamma_T - \gamma_{NT} = \mu_{GT}/\mu_T (\gamma_{GT} - \gamma_{NT})$	0.002	- 0.000	- 0.003	- 0.006	- 0.010	- 0.013
μ_{RNI}/μ_{NT}	3.566	3.578	3.590	3.604	3.620	3.637
$(\gamma_{TNI} - \gamma_{RNI})$	0.019	0.021	0.024	0.025	0.026	0.025
$\gamma_{NT} - \gamma_{TNI} = \mu_{RNI}/\mu_{NT} (\gamma_{TNI} - \gamma_{RNI})$	0.069	0.077	0.085	0.091	0.094	0.091
μ_D/μ_{TNI}	0.470	0.468	0.467	0.466	0.466	0.465
$(\gamma_{XI} - \gamma_D)$	0.059	0.067	0.075	0.080	0.080	0.068
$\gamma_{TNI} - \gamma_{XI} = \mu_D/\mu_{TNI} (\gamma_{XI} - \gamma_D)$	0.028	0.032	0.035	0.037	0.037	0.031

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