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**Reduced Tax Progressivity in
Norway in the Nineties**
The Effect from Tax Changes

Abstract:

The inequality in pre-tax income increased in Norway in the 1990s, while the concentration of taxes remained largely unaltered. This means that tax progressivity has decreased in the period, as measured by summary indices of tax progressivity. In this paper I analyze individual income data to ascertain whether tax changes in the period can explain the observed decrease in tax progressivity. As marginal tax rates at high income levels have been substantially reduced in the period, for instance through the tax reform of 1992, it is expected that tax changes may have influenced the degree of inequality in pre-tax incomes. This behavioral effect is examined by deriving estimates of the elasticity of gross income with respect to the net-of-tax rate, obtained from various panel data regressions. The tax changes may also have shifted the distributional burden of taxes for unaltered level of pre-tax income inequality. In order to identify this (direct) effect of tax-law alterations, the same fixed distribution of pre-tax income is exposed to various tax-laws in the period.

Keywords: tax progressivity measurement, fixed-income calculations, gross income elasticity, panel data

JEL classification: H24; H31; J22

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1. Introduction

Like several other tax reforms in OECD countries, such as the U.S. Tax Reform Act of 1986, the 1992 Norwegian tax reform introduced large reductions in marginal tax rates at high income levels. While the tax reform of 1992 entailed substantial cuts in the marginal tax rates during the 1990s, the extent to which overall tax progressivity declined remains an open question. It depends on the overall mix of tax changes, including changes in income deduction thresholds and tax deduction thresholds. The first issue I address in this paper therefore concerns tax progressivity changes in the period 1991–99. By exploiting information from income tax returns, empirical measures that describe the trends in tax progressivity are derived. Two progressivity indices are applied, and results based on the progressivity index that is invariant with respect to tax height, the disproportionality measure (Kakwani, 1977), show that tax progressivity fell by 12 per cent from 1991 to 1999, though the decline is somewhat smaller according to the index that measures the redistributive effect (Musgrave and Thin, 1948).

The main purpose of this paper is to identify the contributions of altered tax-laws on this reduction in progressivity. To give an introduction to the approach that is followed, let us consider the following representation of tax progressivity: Let T symbolize taxes and X symbolize pre-tax income. Then the disproportionality index defines tax progressivity as the degree of concentration of the tax burden (when individuals are ranked according to pre-tax income, as denoted by topscript X) compared to the inequality of pre-tax income, $\gamma_T^X - G_X$, where G_X is the inequality in pre-tax income measured by the Gini coefficient and γ_T^X is the concentration coefficient for the distribution of taxes. Thus, the decline in tax progressivity may therefore be an effect of widened inequality in pre-tax income (G_X), or of a fall in the concentration coefficient for tax burdens (γ_T^X), or it follows from a combination of these two effects. In other words, tax-law changes may both have affected the distribution of tax burdens, for a fixed degree of inequality in pre-tax income, and the distribution of pre-tax incomes.

In accordance with this, the search for empirical evidence is twofold: First, we keep the distribution of pre-tax income fixed at a base level and expose it to various tax-laws in the period. By applying tax-laws from various years to the same fixed distribution of pre-tax income a number of tax-law amendments that has contributed to the tax progressivity reduction are identified. This part of the analysis is related to work done by Kasten, Sammartino and Toder (1994).

Secondly, as it is well known that tax-law changes may affect individuals' behavior, it is important to include the effects on income inequality through behavioral adjustments. For instance, lower marginal tax rates might stimulate labor supply and other income-generating activities, which in

turn influence the distribution of pre-tax income. Recent analyses in the United States of the relationship between tax reforms and post-reform income growth (cf., e.g., Lindsey, 1987; Feldstein, 1995; Auten and Carroll, 1999; Moffitt and Wilhelm, 2000; Gruber and Saez, 2002) indicate that lower marginal tax rates affect pre-tax incomes, though they do vary with respect to the strength of this relationship. These studies¹ treat tax reforms as "natural experiments" and utilize variations in marginal tax rates and observations of incomes before and after reforms to identify the tax responsiveness of income. In the present analysis a panel data set that contains information on incomes and taxes for a number of individuals for each year during the period 1991–99 is employed. Longer post-reform panel data denotes a rich source of information, that allows us to address the long-term effects of the reform, and is also helpful in order to specify instruments for changes in marginal tax rates. The results with respect to the effect of marginal tax rates on pre-tax incomes are reported in terms of elasticity estimates of the relationship between gross income and the net-of-tax rate, where the net-of-tax rate is one minus the marginal tax rate.

The plan of the paper is as follows: I give a brief description of the main features of the Norwegian tax system and the changes it went through during the 1990s in Section 2. The measurement of tax progressivity over time represents a challenge inasmuch as the information is derived from income tax returns. The major problem is that definitions of income and taxes typically follow prevailing tax-law definitions, and these definitions change. Therefore, corrections have been made to establish comparable measures of tax progressivity over time, and these are discussed in Section 3, before providing estimates of the trend in tax progressivity 1991–99. In Section 4 the effects of tax changes with respect to the distribution of the tax burden are analyzed in terms of a fixed-income approach, while Section 5 reports results of various panel data regressions in order to identify the relationship between lower marginal tax rates and the increased inequality in pre-tax incomes. Section 6 concludes.

In summary, the study found a rise in the inequality of pre-tax income in the period, which was not accompanied by an increase in the concentration of tax burdens sufficient to maintain the level of tax progressivity. Tax changes that have led to progressivity reductions, for a fixed level of pre-tax income inequality, are identified, such as the 1992 tax reform and the deficient adjustments of income deduction thresholds. Moreover, elasticities of gross income with respect to net-of-tax rates in the range from 0 to approximately 0.2 are found. These results are in accordance with the main findings in Aarbu and Thoresen (2001), and suggest that effects of behavioral adjustments to lower marginal tax rates at high income levels are likely to have had a relatively small effect or no effect on pre-tax income inequality.

¹ Which belong to a sizeable literature characterized by Goolsbee (2000) as the New Tax Responsiveness literature.

2. A brief outline of the Norwegian tax system

The period under consideration began with the implementation of the 1992 tax reform – a major change in taxation. The reform entailed the adoption of a dual income tax system (cf. Sørensen, 1998), with a single basic tax rate at 28 per cent for both capital and labor. In addition, wage income and incomes from self-employment are subject to a social security tax and a two-tier surtax. Compared to the tax system before 1992, the reform involved substantial reductions in top marginal tax rates both for employees and for self-employed taxpayers. The reform widened the gap between statutory capital income taxation and taxation of income from labor and self-employment. It also involved an imputation method for income from self-employment and income from closely held private corporations.² Broadly speaking, this method aims at splitting total income from a business into an imputed labor income part and a capital income part (which is why it is sometimes called "the split model"). The capital income part is found by multiplying the book value of tangibles with a risk-adjusted interest rate, while the residual income is classified as imputed labor income. The reform changed taxation of dividends from double taxation at both the corporate and individual level to taxation of corporations alone. In order to ease distributional effects, the standard deductions were increased after the reform.

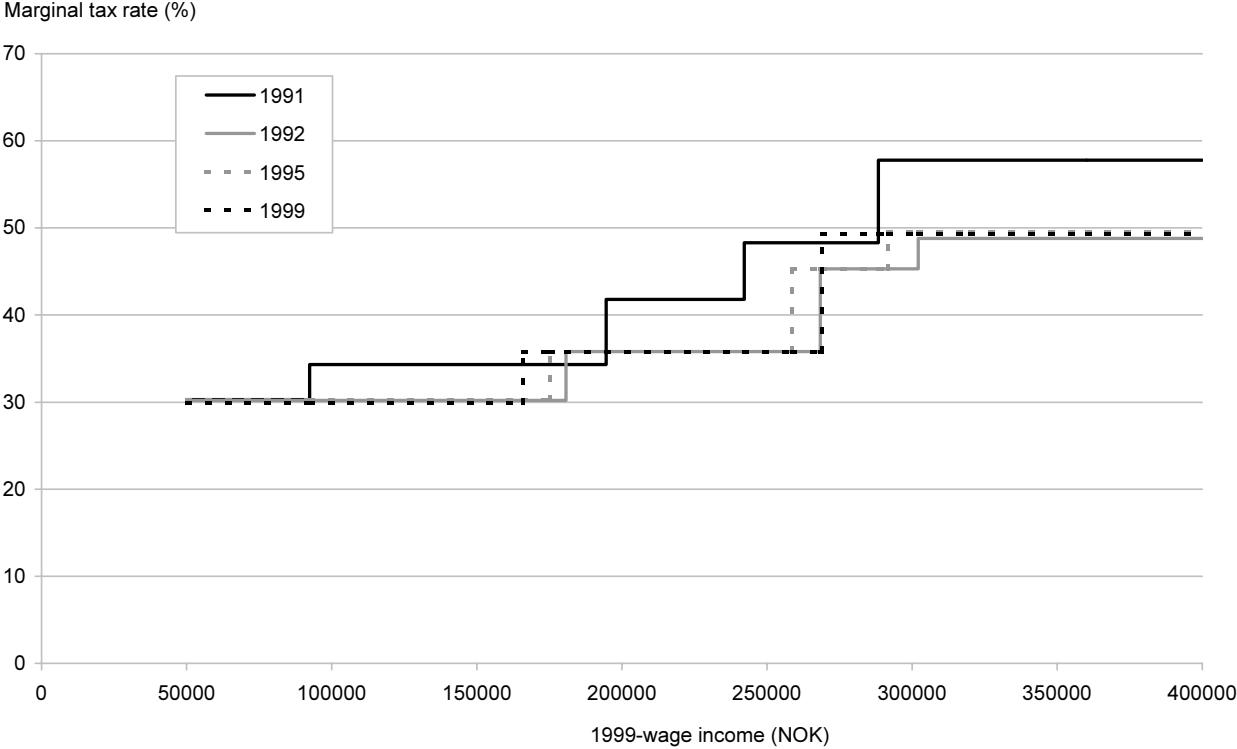
In Figure 1, pre-reform marginal tax rates (1991) for wage income³ in Norwegian kroner (NOK) are compared to marginal tax rates in 1992, 1995 and 1999. In order to make the tax systems for various years comparable, the thresholds have been adjusted by the increase in the average wage in the period.⁴ As seen in the figure, the period after the reform has also involved some adjustments in the tax system.

² If the owner or owners actively participate in the operations of the business and own more than two thirds of the shares, they are liable for taxation by the rules for closely held corporations.

³ The tax function for the self-employed is more complicated, but will basically show the same pattern with respect to time as Figure 1.

⁴ This method of inflation level adjustments is in accordance with current practice by tax bureaucrats.

Figure 1. Marginal tax rates on wage income in 1991, 1992, 1995 and 1999. Wage adjusted thresholds (1 USD≈7 NOK, Jan. 2004)



3. Tax progressivity 1991-1999 – measures and measurement problems

3.1 Comparisons across households and over time

This section provides empirical measures of the trend in tax progressivity in the period from 1991 to 1999 based on micro data from Statistics Norway’s Income Distribution Survey. The Income Distribution Survey is a yearly sample-based survey comprising information from income tax returns and social security registers. However, before proceeding, I describe the steps that were taken to make incomes and taxes comparable both across households and across time. First, with respect to the comparability across households of different sizes, income is measured by equivalent income, which is derived by aggregating income over household members, weighing with an equivalence scale, and

letting each household be represented with as many persons as there are household members.⁵ The economies of scale in households are represented by the square root of the number of household members.

Next, when comparing income and taxes over time, we need to overcome a major difficulty associated with data derived from income tax returns. While income tax returns are an important source of information for studies of income inequality in several countries, among them the Nordic countries and the U.S., the problem with data from government registers is that they often reflect the bureaucratic purpose of collecting them. For instance, observed differences in income over time might simply reflect changes in income definitions. In reform periods, in particular, one should carefully explore whether income and taxation measures at different stages are comparable and the extent to which they reflect changing accounting rules. Pre-tax income includes wage income, income from self-employment, capital income including dividends, and a number of tax-free benefits such as the child benefit, housing benefits, social security benefits. Interest expenses, such as those accruing from house purchases, are not deducted due to the undervaluation of imputed income from owner-occupied homes in our data. The individual tax burdens are derived from tax-benefit model calculations. The deviation between these estimates and actual taxation is negligible.

The following adjustments are made in order to construct comparable measures in the period:

- Even if important base-broadening initiatives were taken in the period prior to the 1992 tax reform, the tax reform implied changes in tax bases. For instance, post-reform income from self-employment is adjusted with respect to altered tax depreciation rates.
- Some gains from realizations, for instance from selling shares, were not taxable before the reform and are therefore not included in taxable gross income for 1991. A symmetric treatment implies that neither gains nor losses are included in 1991, while both are included in measures for the period 1992–99. Self-employment losses are treated similarly.
- Typically, the number of tax-exempt income components represented in the data increase over time due to improved access to information. Only income components that are present in data in each year in the period are included in the series.
- There are reasons to expect altered corporate behavior in response to tax reforms (Gordon and Mackie-Mason 1994; Gordon and Slemrod 2000). For instance, the reform of 1992 might have altered incentives to pay out dividends or retain earnings. Fjærli and Aaberge (2000) show that while post-reform total return to shares is more or less in accordance with an estimated long-term real rate of return, this is not the case in the pre-reform period. Hence, in order to avoid income

⁵ Similar to what Ebert (1997, p. 235) describes as Method 3.

reporting changes impacting on results, the figures for 1991 and 1992⁶ are adjusted with respect to the average ratio between actual income from dividends and the (imputed) return on shares that follows from the long-term rate of return (Table 5 in Fjærli and Aaberge, 2000).

3.2 Tax progressivity indices

The distributional effect of taxes is often characterized by global measures of tax progressivity, cf. Lambert (1993a).⁷ A global measure of tax progressivity refers to the interaction between the tax system and the pre-tax income distribution to which it applies. Here two familiar Gini-based indices of tax progressivity are applied, the disproportionality measure and the redistributive effect. As noted in Section 1, the disproportionality measure (Π_D) (Kakwani, 1977), can be seen as

$$(3.1) \quad \Pi_D = \gamma_T^X - G_X,$$

where G_X is the inequality in pre-tax income measured by the Gini coefficient and γ_T^X is the concentration coefficient for the distribution of taxes, when individuals are ranked by pre-tax income, as indicated by the top script X . Π_D will equal zero when the distribution of tax burdens is identical to the distribution of pre-tax income.

Various measures of tax progressivity can give contradictory results.⁸ One important characteristic of the disproportionality measure is that it is scale invariant, in the sense that it is not affected by changes in tax revenue. This contrasts with the redistributive effect (Musgrave and Thin, 1948), Π_R , which can be defined as

$$(3.2) \quad \Pi_R = G_X - G_Y,$$

where G_Y is the inequality in post-tax income measured by the Gini coefficient. The redistributive effect measures tax progressivity by comparing the distribution of pre-tax income to the distribution of after-tax income. Contrary to the disproportionality measure, the redistributive effect draws its component parts from two (generally) disparate rankings of individuals. When the inequality in the distribution of after-tax income equals the inequality in the distribution of pre-tax income, the

⁶ 1992 incomes are adjusted because of the one-year lag between the accounting year and the year in which the households receive dividends.

⁷ Lambert (1993a) makes a distinction between tax progression and tax progressivity, where the former refers to local measures. Both local and global measures are found in the seminal work of Musgrave and Thin (1948).

⁸ Relying on summary measures of inequality is another source of uncertainty, since it must imply some sort of aggregation. Cf. Bishop et al. (1997) for a study that employs dominance measures of progressivity, i.e. comparisons of Lorenz-curves.

redistributive effect will equal zero.⁹ Kakwani (1984) has demonstrated a connection between the two progressivity measures, the disproportionality measure and the redistributive effect:

$$(3.3) \quad G_X - G_Y = \frac{\mu_T}{\mu_Y} \Pi_D - [G_Y - \gamma_Y^X] = \frac{\mu_T}{\mu_Y} \Pi_D - r_p,$$

where μ_T and μ_Y are mean tax and mean after-tax income, respectively, and γ_Y^X shows the concentration of after-tax income when units are ranked according to pre-tax income. Equation (3.3) shows that the difference between the disproportionality measure and the redistributive effect is that the latter contains an expression both for tax level (μ_T/μ_Y) and for the extent of reranking, defined by $r_p = G_Y - \gamma_Y^X$. Reranking refers to the fact individuals change places in the income ranking in consequence of the tax system, in the changeover from pre-tax income to post-tax income. The index r_p measures the degree of reranking as the difference between the distributions of post-tax income when units are ranked according to post-tax income and pre-tax income, respectively.

3.3 Tax progressivity in Norway 1991-99

Table 1 shows the trend in tax progressivity 1991–99, as measured by disproportionality and the redistributive effect. It also shows estimates for the reranking measure. We see that the inequality in pre-tax income rose by about 6 per cent in the period under consideration, while the concentration of tax payments remained largely unaltered and the inequality in post-tax income widened by about 8 per cent. The bottom two lines of Table 1 show that this gives a reduction in tax progressivity, as evaluated by both progressivity indices. However, the disproportionality measure shows a stronger reduction in tax progressivity in comparison to the evaluation by the redistribution measure, 12 per cent and 7 per cent, respectively. Due to the large number of observations in each year the reduction is significant by both measures.¹⁰ Thus, a reasonable interpretation of the results from Table 1 is that we are seeing a notable but modest reduction in tax progressivity from 1991 to 1999.

The disparate evaluations by the two measures of tax progressivity are due to two factors, as mentioned above. First, the disproportionality measure is unaffected by changes in tax revenue, while the decrease in the redistributive effect is dampened by the increase in tax revenue from 1991 to 1999, cf. equation (3.3). Figure 2 shows that tax revenues rose significantly in the period under investigation. In total, the authorities collected about 50 per cent more taxes in 1999 than in 1991.

⁹ Thus, the redistributive effect is unaltered with respect to a proportional change in the distribution of post-tax incomes, while the disproportionality measure is unaffected by a proportional change in the distribution of the tax burden.

¹⁰ Cf. discussion in Bishop, Formby and Zheng (1998) on tax progressivity indices and statistical inference.

Second, the tax system as it was in 1999 caused fewer individuals to change positions in the transition from pre-tax to post-tax income than the tax system in operation in 1991. In other words, the reranking effect of the tax system diminished in the period, as seen by measures of the reranking effect in Table 1.

Table 1. Tax progressivity measured by disproportionality and the redistributive effect, 1991–99. Equivalent income. Number of observations in parentheses

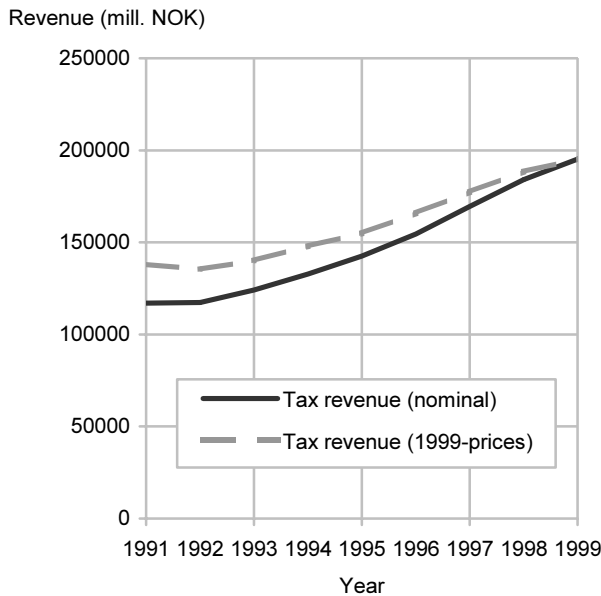
	1991 (24,446)	1992 (24,010)	1993 (18,404)	1994 (41,112)	1995 (21,873)	1996 (37,980)	1997 (39,504)	1998 (38,938)	1999 (26,825)	1991– 99 (%)
Inequality in pre-tax income, G_X	0.276	0.280	0.286	0.294	0.288	0.298	0.303	0.292	0.293	+6.1
Tax burden concentration, γ_T^X	0.416	0.419	0.422	0.425	0.416	0.424	0.427	0.410	0.416	+0.5
Inequality in post-tax income, G_Y	0.235	0.242	0.247	0.254	0.249	0.259	0.262	0.254	0.255	+8.4
Reranking effect, r_p	0.004	0.003	0.002	0.002	0.002	0.002	0.002	0.002	0.003	-13.7
Redistributive effect, Π_R	0.041	0.038	0.039	0.040	0.040	0.040	0.040	0.038	0.038	-7.2
Disproportionality, Π_D	0.140	0.139	0.136	0.131	0.128	0.126	0.124	0.118	0.121	-12.0

As noted in Section 2, the tax reform of 1992 abolished the double taxation of dividends; dividends are now taxed at the corporate level only.¹¹ There is support in the tax incidence literature to argue that these taxes should be assigned to individuals. Table A1 in the Appendix shows tax progressivity measures when taxes paid on dividends in the corporate sector are allocated to the individuals.¹² Table A1 shows that tax progressivity measured by disproportionality under this alternative definition of the tax burden fell in the period, however, at a smaller rate than indicated by measures reported in Table 1. Table A1 also shows that according to the redistributive effect progressivity increased in the period, which signifies previous reports on various progressivity measures contain conflicting results.

¹¹ However, this is a highly debated issue, and most likely we will see a return of the double taxation system in the future.

¹² In post-reform years this can be done straightforwardly by noting that the dividends received by the individual are net of taxes (28 per cent flat rate) paid by the firms. In pre-reform years the taxation of dividends in the corporate sector depend on variables not present in the data. Hence, for these years corporate taxes on dividends are imputed by applying a factor for average taxation of profits in firms, based on findings in Askildsen and Fjærli (1989).

Figure 2. Income tax revenues, taxation of individuals 1991–99 in nominal prices and 1999-prices. In million Norwegian kroner (1 USD≈7 NOK, Jan. 2004)



Following Pfähler (1987), Formby, Smith and Thistle (1990) and Lambert (1993b), it can be argued that tax progressivity evaluations over time are best understood in a revenue-neutral setting. If estimates for the redistributive effects were adjusted with respect to tax revenue differences, the evaluation by the redistributive effect would be closer to the evaluation by disproportionality. Only the effect from reranking would lead to divergences.

As stated above, the main purpose of this paper is to generate knowledge concerning the relationship of tax changes to decreased tax progressivity. Musgrave and Thin (1948) have suggested that "the less equal the distribution of income before tax, the more potent will be a (given) progressive tax structure in equalizing income" (p. 510). If this prediction has any significance,¹³ there must have been some tax changes in the period that weakened the progressivity effect of the tax system. Why, in other words, was the more unequal distribution of pre-tax income not followed by an even more unequal distribution of taxes? Optimal tax theory, for instance, predicts that growing inequality (of pre-tax income) would lead to increased progressivity (Slemrod and Bakija, 2000; Sandmo, 2002).

The next sections explore in detail the relationship between tax changes and the observed fall in $\Pi_D = \gamma_T^X - G_X$ from 1991 to 1999. The search for evidence is divided into separate analyses of the relationship between tax changes and the development in γ_T^X (for a fixed distribution of X) and the effects from tax changes on G_X .

¹³ Lambert and Pfähler (1992) and Milanovic (1994) discuss to what extent it really has.

4. Fixed-income calculations

To see how tax changes affected the distribution of tax burdens, a "fixed-income" approach to tax progressivity measurement is applied.¹⁴ While keeping pre-tax income inequality constant, we employ a tax-benefit model for Norway to calculate taxation in respect of various tax-laws.¹⁵ By letting the same pre-tax income distribution be exposed to taxation as per various tax-laws in the period, the (direct) contribution from tax changes can be identified. When tax regulations diverge from the point of time of the pre-tax income distribution, they are inflated or deflated to match the pre-tax income distribution by a factor based on developments in wage per normal man-year. This means that all thresholds, including income deduction thresholds¹⁶ and tax deduction thresholds, are adjusted by the wage growth. The distribution of pre-tax income will be unaffected by the application of tax regulations for different years, apart from the effect of the child benefit. The child benefit is included in pre-tax income and is calculated according to the regulations applicable to various years. Since the simulations are not revenue-neutral, progressivity estimates only for the measure that is unaffected by tax height, the disproportionality measure, are presented. Note that the results in general are not independent of the choice of base year.¹⁷

A number of tax-law changes might have contributed to the observed reduction in tax progressivity. Table 2 explores the effects from a selection of tax changes. Table 2 is divided structurally into effects of the 1992 tax reform and effects from post-reform tax system adjustments. While the results in Table 2 indicate that none of the progressivity-dampening tax-law changes resulted in large changes in the degree of progressivity, as measured here, there are some notable effects.

Let us first address the effect of the 1992 tax reform.¹⁸ We do so by deflating the tax-law of 1992 to the 1991 level, and contrasting the simulation results of the (deflated) 1992 tax-law on 1991 incomes with the results of a simulation where 1991 incomes are taxed by 1991 rules. Letting 1991 incomes be taxed by the 1992 tax-law is not straightforward; it means, for instance, that the split model is calculated on a pre-reform data set. However, the simulation exploits that data for 1991 were collected with respect to new income concepts of the 1992-reform.

¹⁴ Cf. Kasten, Sammartino and Toder (1994) for an application of this method when evaluating the trend in U.S. tax progressivity 1980–93, and Decoster and Van-Camp (2001) and Johnson and Webb (1993) for related approaches when discussing reforms in the Belgian tax system and trends in income inequality in the U.K., respectively.

¹⁵ Sutherland (1995) gives descriptions of tax-benefit models.

¹⁶ Fixed amount or a fixed share of income that is deducted in order to arrive at taxable income, sometimes called allowances or exemptions.

¹⁷ Cf. the approach suggested by Dardanoni and Lambert (2002) to establish a common baseline or a reference situation, from which one can determine the tax progressivity orderings of intertemporal tax schemes.

¹⁸ Section 2 provides a more detailed exposition of the reform.

We saw in Table 1 that tax progressivity, as measured by disproportionality, fell from 0.140 in 1991 to 0.139 in 1992. Our calculations indicate that the isolated direct effect of tax legislation amendments was a stronger reduction in progressivity, from 0.140 to 0.135. More elaborate simulations show that the cause can be found in the tax rate reductions (Aarbu and Thoresen, 1997). A natural follow-up hypothesis would be that the increases in standard deductions have not quite managed to make up for the rate reductions.

Table 2. Fixed-income calculations of tax progressivity effects of tax-law changes. Tax-benefit model simulations

	Fixed-income simulations	Progressivity measured by disproportionality
Effect of the tax reform	Wage-deflated 1992 tax-law applied to 1991 incomes	0.135
	Baseline: 1991 tax-law applied to 1991 incomes	0.140
Effects of post-reform changes	The 1992 split model applied to 1999 incomes	0.123
	Wage-inflated 1992 tax-law applied to 1999 incomes, except adjustments in the split model	0.126
	As above, except that only 1992 allowances wage-inflated to 1999	0.127
	Wage-inflated 1992 tax-law applied to 1999 incomes, except adjustments in the split model and the child benefit	0.125
	Baseline: 1999 tax system applied to 1999 incomes	0.121

With respect to effects of post-reform changes in the tax system, various simulations are carried out on the basis of the 1992 tax-law in order to identify the sources of the decreasing progressivity of that period. These simulation results are to be compared with the baseline simulation result at 0.121 (1999 tax system applied to 1999 incomes, cf. bottom line of Table 2). A number of tax policy changes in the period are addressed.

Firstly, the split model was modified after its introduction in 1992. Most importantly, it was adjusted with respect to the maximum values for the imputed labor income part of overall income (cf. the presentation of the Norwegian tax system in Section 2). By employing the 1992 split model on 1999 incomes and comparing the degree of tax progressivity according to this simulation with the baseline result, we can identify the effect of this tax-law change. The figures in Table 2 indicate a

minor effect. If the 1992 version of the split-model had been utilized in 1999, tax progressivity would have increased to 0.123, compared to 0.121 in the baseline.

Secondly, annual amendments in tax legislation are based on predictions of wage income rises for the following year. Since these predictions constantly underestimate the actual rise in wages, there is reason to assess the effects of this procedure. Table 2 shows that if the 1992 tax-law (not including the 1992 split model) had been adjusted by the actual wage growth in the period, tax progressivity would have increased to 0.126.

Thirdly, to further elaborate on the effect of adjusting tax-laws according to low wage growth predictions, tax progressivity under the condition that only allowances are adjusted according to the actual wage growth is shown in Table 2. Then, as expected, tax progressivity increases more than in the previous example, to 0.127.

Fourth, Table 2 also indicates that the isolated effect of not adjusting the child benefit in accordance with real wage growth played a part in reducing tax progressivity; compare simulations with and without child benefit adjustments.

To sum up so far, the fixed-income calculations have identified a number of tax-law changes that had tax progressivity reducing effects, that is, our simulations show progressivity enhancing effects of not amending taxation legislation as was done. For instance, it is shown that both the tax reform of 1992 and the persistent underestimation of wage growth when inflating tax-laws have had an effect.

5. Tax changes and effects on the distribution of pre-tax income

5.1 Empirical strategy to identify behavioral effects

I argued above that the tax system progressivity decreased from 1991 to 1999. On the basis of several tax-benefit model simulations, certain tax changes were identified as contributive factors. The next question concerns how tax changes affected inequality in pre-tax income over the period. There are reasons to assume that lower taxation at the margin causes individuals to increase their income. Even though there might be some undetermined relationship between increasing inequality in equivalent household income and responses to tax changes, it can be argued, as Auten and Carroll (1999) do, that strong behavioral responses in an era of rate reductions at high income levels induce increased dispersion. Here, I address the relationship between pre-tax income growth and the net-of-tax rate¹⁹ on basis of information from a panel data set for the period 1991–99. In order to control for effects of

¹⁹ Remember that the net-of-tax rate is one minus the marginal tax rate.

other factors that might have contributed to the increase in pre-tax income inequality a number of other individual characteristics are included in the regressions.

The present analysis is related to the approach taken by Aarbu and Thoresen (2001), who utilized panel data information and employed the differences-of-differences estimator in order to identify effects of the Norwegian tax reform. Aarbu and Thoresen (2001) followed closely Feldstein's (1995) approach, comparing incomes in 1991 and 1994 for the same individuals, and dividing the taxpayers into an "experiment group" and a "treatment group", under the assumption that the tax reform constituted a "natural experiment".

Now, with a longer series of panel data at hand, the information on taxpayers' behavior over a longer time period can be examined, without relying on information from arbitrarily chosen years after the reform. Thus, in the present analysis post-reform behavior is represented by information on incomes at several points of time after the reform, since it exploits information from panel data covering the period 1991–99. These data will also reflect behavioral adjustments, if any, with respect to post-reform net-of-tax rate modifications, as seen in Figure 1.²⁰

It is assumed that the following linear approximation can be applied in order to let pre-tax income, X , for individual i at time t to be explained by k regressors, taxes included, Z_{it} , in addition to an unobservable individual effect, δ_i , a time effect, λ_t , and a constant, α ,

$$(5.1) \quad X_{it} = \alpha + \beta Z_{it} + \delta_i + \lambda_t + u_{it} \quad i = 1, \dots, N; \quad t = 1, \dots, T.$$

The main approach in the New Tax Responsiveness literature is to estimate a first differenced version of 5.1 in order to eliminate the unobserved individual effect, following Feldstein (1995). The dependent variable is therefore the change in income between periods, for instance between pre-reform and post-reform years. A significant problem is that the tax variable is non-exogenous, i.e. the tax variable is correlated with the error term of a first differenced setup of (5.1) since taxation is jointly determined with income (Moffitt and Wilhelm, 2000). This problem is often addressed by employing instrumental variable methods. Feldstein (1995) used the first period marginal tax rate levels as instrument, but this method might be sensitive to regression to the mean biases, caused by correlation between the instrument and the first differenced error term, for instance because some individuals erroneously are defined as high-income earners in the first period, due to temporary swings in income. Control for mean reversion had a large impact on elasticity estimates in Aarbu and Thoresen (2001), and similar findings are reported in studies based on U.S. data; see Auten and

²⁰ There have also been some adjustments of net-of-tax rates for self-employed tax-payers.

Carroll (1999) and Gruber and Saez (2002). The longer series of panel data permit employing specifications that address the joint problem of validity of retention rate instruments and mean reversion controls, and this study employs 3 different specifications in order to derive elasticity estimates. The alternative approaches can be described by considering a first differenced version of equation (5.1). In equation (5.2) the difference between income in period 2 and income in period 1 in log form is the dependent variable, while period 1 and period 2 net-of-tax rates are represented by $(1-\tau_1)$ and $(1-\tau_2)$, respectively:

$$(5.2) \quad \log(X_2/X_1) = \kappa + \eta \log\left[\frac{(1-\tau_2)}{(1-\tau_1)}\right] + \gamma R + \varepsilon .$$

Thus, η measures the elasticity of pre-tax income with respect to changes in net-of-tax rates. The time effect is embedded in the constant term, κ , other explanatory variables are symbolized by R , while ε represents the first differenced error term.²¹

The 3 different methods of deriving estimates of η are briefly as follows. In the first specification the difference between average post-reform income in the period 1992–99 and pre-reform income (1991) is employed as the dependent variable, corresponding to $\log(X_2/X_1)$ in equation (5.2). Further, $\log\left[\frac{(1-\tau_{\text{INS}})}{(1-\tau_{1991})}\right]$ is used as instrument for the net-of-tax rate change, where τ_{1991} is the marginal tax rate in 1991 calculated on basis of 1991 incomes, while τ_{INS} is the marginal tax rate that follows from letting the individuals' 1991 incomes be adjusted to the 1992 level and taxed according to the tax rules of 1992, similar to approaches in Auten and Carroll (1999), Aarbu and Thoresen (2001), Gruber and Saez (2002). The problem of mean reversion is controlled for by adding initial income as an independent variable, as suggested by Moffitt and Wilhelm (2000). This specification aims at identifying the effects of the reform of 1992, also in a longer perspective.

The second specification utilizes that we have seen adjustments in the net-of-tax rates also after the reform (cf. Figure 1 above), letting six 3-year differences in income, 1991–1994, 1992–1995, ..., and 1996–1999, be explained by differences in retention rates for the same years, respectively. 3-year differences are often seen in the literature. Moreover, a net-of-tax rate instrument that might be less sensitive to mean reversion is employed. Here, following Carroll (1998), the individual average gross income in the period 1991–99 serves as basis for the marginal tax rate calculations in each year in order to establish tax rate instruments. For instance, $\log\left[\frac{(1-\tau_{\text{AVE91}})}{(1-\tau_{\text{AVE94}})}\right]$ is employed as instrument for the tax change between 1991 and 1994, where τ_{AVE91} is the marginal tax rate the individual would face in 1991 in terms of his "permanent income", which is proxied by his average income 1991–1999, while τ_{AVE94} is the marginal tax rate that he would face in

1994, based on the same income concept. As one cannot rule out that this instrument correlates with the first period transitory component, as noted by Kopczuk (2003), log of first period income is included as mean reversion control.²² Time dummies are included in this specification.

The third specification follows the approach suggested by Gruber and Saez (2002). The dependent variable is six 3-year differences in income, 1991–1994, 1992–1995, ..., and 1996–1999, as in the second specification. The tax change instrument is however $\log[(1-\tau_{INS2})/(1-\tau_1)]$, where τ_1 is the marginal tax rate in the first year, while τ_{INS2} is the marginal tax rate in year 2, based on first year income. τ_{INS2} is calculated by letting the individuals' incomes in the first year be adjusted to the level of the second year and taxed according to the tax rules of the second year. Gruber and Saez (2002) argue that it is important to control for nonlinearities in the first period mean reversion control, and by employing information from a number of years of data, one can add a spline function based on first year income, and still be able to identify tax effects.²³ A 10-piece spline, describing the individuals' positions in the first period income ranking, is therefore included, in addition to the mean reversion control (log of first period income). Dummies are included as time controls.

In accordance with numerous studies from the U.S. (Feldstein, 1995; Auten and Carroll, 1999; Moffitt and Wilhelm, 2000; Gruber and Saez, 2002),²⁴ and since Aarbu and Thoresen (2001) did not reject a small positive elasticity, one expects to find a positive relationship between the net-of-tax rate and pre-tax income growth.

A number of other variables are included in addition to the net-of-tax rate variable, in order to control for the observed heterogeneity. As many of them do not vary over time, the initial period (1991) characteristics²⁵ are included in the first-differenced equation. The relationship between income and the time-invariant variables might have changed in the period and may therefore have contributed to the income inequality growth. The time-invariant variables include: education; age; age squared; a dummy variable for the sex of the taxpayer that takes the value 1 if the individual is a female; an Oslo-area dummy variable that covers inhabitants in the capital and the neighboring municipalities; a dummy variable that takes the value 1 if the individual is self-employed; a dummy variable that takes the value 1 if the individual received dividends in 1991; and net wealth.²⁶ Time-variant measures are employed for the variables representing the number of children aged 0–3 years;

²¹ Note that the individual level notation is suppressed in equation (5.2).

²² However, as expected, results are less dependent on whether the mean reversion control is included or not.

²³ They argue that this also controls for a trend towards increased income inequality in the U.S., in addition to mean reverting effects. Such an interpretation cannot be justified with respect to Norway, as a persistent trend towards more disparate incomes has not been verified.

²⁴ However, there are studies from the U.S. that report small elasticity estimates, cf. the survey in Gruber and Saez (2002, p. 5).

²⁵ Values for 1992 is employed for the variable representing education.

the number of children aged 4–9 years; the number of children aged 10–16 years; and the marital status of the taxpayers.

5.2 Data

For this part of the analysis a subsample of individuals participating in the yearly Income Distribution Survey were entered into a panel spanning 1991–1999. The analysis is restricted to prime aged individuals, as is usually the case in studies of incomes over time, cf. e.g. Feldstein (1995) and Burkhauser, Holtz-Eakin and Rhody (1997); taxpayers aged 25–55 years in the period 1991–1999. The panel contains information concerning about 2,150 individuals. To avoid including individuals that basically get their incomes from pensions, the sample is restricted with respect to source of income. After excluding individuals who have divorced during the period and one very high income observation, and restricted the sample to individuals with income above 10,000 NOK in period 1, then the resulting panel consists of about 1,500 wage earners or self-employed individuals, observed over 9 years.

The dependent variable in the analysis, the difference in pre-tax income, is approximated by the difference in gross income, where gross income includes wage income, income from self-employment, and capital income, including capital gains and losses.²⁷ Income is inflated to the 1999 level by the average wage growth in the period. Table 3 shows year-specific means for this gross income concept and actual marginal tax rates in the sample.

Table 3. Year-specific means for gross income (NOK) and actual marginal tax rates (%) in panel, 1991–99. Income inflated to the 1999 level by the average wage growth (1 USD≈7 NOK, Jan. 2004). Standard deviations in parentheses

	1991	1992	1993	1994	1995	1996	1997	1998	1999
Gross income (NOK)	311,707 (181,685)	313,310 (168,942)	311,402 (175,437)	315,385 (194,347)	320,140 (210,447)	321,686 (190,134)	330,475 (250,352)	331,750 (194,577)	335,146 (229,952)
Marginal tax rate (%)	44.6 (10.3)	40.9 (7.6)	41.5 (8.1)	42.1 (8.0)	42.7 (7.6)	43.0 (7.4)	42.7 (7.5)	42.8 (7.4)	42.5 (7.6)

²⁶ Note that the wealth variable is truncated at zero.

²⁷ It is assumed that this definition is close to the Adjusted Gross Income definition of the studies from the U.S. Previous studies indicate that elasticity estimates are sensitive to income definitions, for instance whether estimates are based on taxable income or gross income definitions. Moreover, Kopczuk (2003) argues that policy makers can to some extent control elasticity estimates, as they depend on available deductions, and base broadening appears to have reduced elasticity estimates in the U.S. As elasticity estimates in the present study are discussed within the context of possible contributions to pre-tax income growth, it is advantageous to derive elasticity estimates with respect to gross income.

5.3 Results

Elasticity estimates are obtained from two-stage least squares regressions, based on the alternative specifications of the dependent variable and tax change instruments. In the first stage the difference in the actual net-of-tax tax rates is regressed against the particular instrument of the difference in net-of-tax rates and other exogenous variables.²⁸ For each of the three alternatives results from a "taxes-only" variant (including mean reversion controls and variables representing time) and a specification that includes all exogenous variables are shown. All regressions are weighted, employing the average sample weights for each individual over the period 1991–99.

Table 4 shows net-of-tax rate elasticity estimates ranging from about 0 to about 0.17. Thus, these results indicate that lower marginal tax rates during the 1990s are likely to have had a small or no effect on income growth. The results are in accordance with the main findings in Aarbu and Thoresen (2001), based on information from 1991 and 1994, only. Moreover, the results do not indicate that there are stronger long-term effects of the reform, cf. e.g., the results from the specification that focus on effects of the tax reform in Table 4.²⁹ However, it is worth noting that the only significant positive elasticity estimate is derived from the specification that allow for nonlinear mean reversion effects. While this elasticity estimates is smaller than reported by some U.S. studies, it is close to the estimate of the uncompensated elasticity with respect to broad income, reported by Gruber and Saez (2002, p. 16).

The results indicate that elasticity estimates are less sensitive with respect to the inclusion of other explanatory variables, as long as the mean reversion controls are included in the regressions. However, the regressions that include other explanatory variables help identifying which other factors that may have contributed to income growth.³⁰ We see that the parameter for education has a significant, positive sign across the three specifications. This might be a sign of contributions from increased returns to human capital to the increased inequality in pre-tax incomes. One more year at school or university gives an income growth increase of near 2 per cent, as indicated by the results from the specifications that involve 3-year differences. Increasing returns to education have also been reported as a key factor behind the observed increase in wage dispersion in other countries during the 1980s (Gottschalk and Smeeding, 1997).

²⁸ *F*-values of the first stage of the regressions are (in general) high.

²⁹ Results from other regressions (not reported) that address the effect of the tax reform are in accordance with the results reported in Table 4.

³⁰ However, note that definitions of the dependent variable vary across specifications, which affect parameter values.

Table 4. Two-stage least square regression results:^{a)} change in gross income as the dependent variable. Standard errors in parentheses

Specification	One difference, 1991 vs. average 1992–99		Six 3-year differences, tax rate instruments derived from "permanent" inc. ^{b)}		Six 3-year differences, nonlinear mean reversion control ^{c)}	
	Taxes only	Other variables included	Taxes only	Other variables included	Taxes only	Other variables included
Net-of-tax rate elasticity	0.073 (0.059)	0.048 (0.055)	0.016 (0.109)	0.013 (0.109)	0.155 (0.101)	0.166* (0.101)
Education		0.023*** (0.002)		0.017*** (0.002)		0.017*** (0.002)
Age		-0.032*** (0.011)		0.007 (0.011)		0.007 (0.011)
Age squared		3.9×10 ⁻⁴ ** (1.6×10 ⁻⁴)		-1.6×10 ⁻⁴ (1.6×10 ⁻⁴)		-1.5×10 ⁻⁴ (1.5×10 ⁻⁴)
#children 0–3		-0.002 (0.011)		-0.005 (0.011)		0.004 (0.011)
#children 4–9		0.037*** (0.009)		-4.1×10 ⁻⁴ (8.7×10 ⁻³)		0.003 (0.008)
#children 10–17		0.020** (0.009)		6.9×10 ⁻⁴ (8.5×10 ⁻³)		0.112 (0.008)
Dummy for marriage		-0.004 (0.014)		0.017 (0.013)		0.004 (0.013)
Female dummy		-0.123*** (0.012)		-0.085*** (0.012)		-0.099*** (0.012)
Self-employ. dummy		0.029 (0.021)		-0.140*** (0.022)		-0.102*** (0.021)
Net wealth		1.0×10 ⁻⁷ *** (3.2×10 ⁻⁸)		9.8×10 ⁻⁸ *** (3.3×10 ⁻⁸)		6.6×10 ⁻⁸ ** (3.2×10 ⁻⁸)
Dividend recip. dummy		0.074*** (0.017)		0.079*** (0.018)		0.055*** (0.017)
Oslo-area dummy		0.065*** (0.012)		0.039*** (0.013)		0.028** (0.013)
Log of first period income	-0.245*** (0.014)	-0.355*** (0.015)	-0.172*** (0.012)	-0.258*** (0.015)	-0.441*** (0.043)	-0.475*** (0.043)
Constant	3.115*** (0.173)	4.861*** (0.247)	2.139*** (0.157)	3.005*** (0.257)	5.393*** (0.508)	5.620*** (0.537)

^{a)} In the first stage of the regression the difference in actual net-of-tax tax rates is regressed against the particular instrument of the difference in net-of-tax rates, and other exogenous variables. Regressions weighted by average sample weights over the period.

^{b)} Time dummy variables included.

^{c)} Time dummy variables and 10-piece spline function included.

*significant at 0.10 level, **significant at 0.05 level, ***significant at 0.01 level

Since dividend payments rose during the 1990s from about 1,5 billion NOK in 1991 to about 19 billion NOK in 1999, capital income has been seen as a major factor behind widening income

inequality.³¹ The results confirm that ownership of shares at an early stage of the period has been advantageous, as the dividend recipient dummy is positive. Similarly, the sign for the wealth variable indicate that prosperity in the beginning of the period has contributed positively to income growth.

The results also indicate that place of residence affects income growth, as the Oslo-area dummy variable, that covers individuals living in the capital and the neighboring municipalities, has a positive sign. This may be due to the macroeconomic upswing that set in shortly after the 1992 tax reform (Statistics Norway, 1999), inasmuch enhanced macroeconomic performance is believed to affect on residents in urban areas first, at least initially. It is also worth noting that females do worse than males in the period.

6. Conclusion

Although the inequality in pre-tax income has widened, the tax burden concentration remains largely the same for the period 1991–99. This implies that the level of tax progressivity has declined in the period. The main purpose of this analysis has been to assess the possible contributions of tax changes in the period to this decline. Individual data from income tax returns were utilized.

While Auten and Carroll (1999) find that tax-driven behavioral adjustments contributed to relative income growth in the U.S. in the late 1980s, the effects appear to be somewhat smaller with respect to the Norwegian case in the 1990s. Estimates of the net-of-tax rate elasticities range from 0 to approximately 0.2, which implies that the net-of-tax rate changes have had a limited or no effect on pre-tax income growth. These estimates are close to previous findings, reported in Aarbu and Thoresen (2001). The regression analysis also identified other variables that have contributed to growth in pre-tax incomes, as education and ownership of shares early in the period.

One important feature of the present approach is that it identifies the tax changes that would have counteracted the observed trend. Methodologically, this is done by keeping the pre-tax income distribution fixed and exposing it to various tax-laws in the period. For instance, if policy-makers have increased the value of standard deductions at the same rate as real wage growth in the period, the tax system would have been more progressive. We can therefore say that the current analysis should improve the information available to policy-makers aiming at offsetting the trend towards reduced tax progressivity.

There may well be other responses to tax system alterations not discussed in the present study. For instance, the lack of reliable data has so far prevented us from looking at organizational form adjustments in response to the dual income tax system, for instance that self-employed taxpayers

³¹ Capital income is also an important source of income for the affluent in the U.S. (Slemrod, 1994).

may have decided to organize their activities in a company with themselves as shareholders and employees. One hypothesis worth pursuing is that taxpayers minimize the tax burden by choosing an organizational form that avoids the impact of the split model. Such behavior might help explain the absence of increased tax burdens for the well-off in response to the widened pre-tax income inequality.

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Appendix

Table A1. Tax progressivity measured by disproportionality and the redistributive effect, 1991–99. Alternative definition of tax burden

	1991	1992	1993	1994	1995	1996	1997	1998	1999	1991–99 (%)
Inequality in pre-tax income, G_X	0.276	0.281	0.289	0.298	0.293	0.304	0.307	0.299	0.300	+8.2
Tax burden concentration, γ_T^X	0.417	0.420	0.431	0.437	0.431	0.439	0.441	0.430	0.435	+4.3
Inequality in post-tax income, G_Y	0.235	0.242	0.247	0.254	0.249	0.259	0.262	0.254	0.255	+8.4
Redistributive effect, Π_R	0.041	0.039	0.042	0.044	0.045	0.045	0.045	0.044	0.044	+7.0
Disproportionality, Π_D	0.141	0.140	0.142	0.140	0.138	0.135	0.134	0.131	0.136	-3.4