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Evaluating the redistributional effects of tax policy changes: with an application to the 2006 Norwegian tax reform

Abstract:
An evaluation strategy is presented for answering the question is the tax schedule more redistributive after a reform than prior to a reform? The proposed procedure builds upon addressing measures of tax redistribution, utilizing micro data from periods before and after the reform. Tax redistributional effects are measured in terms of a "common base" approach, which means that a benchmark is established to identify how the "redistributional efforts" of policy-makers develop over time. When applying this method for evaluation of the 2006 Norwegian tax reform, the results suggest that the modification of the dual income tax system of the 2006 reform has improved the redistributional effect of the schedule. This conclusion is qualified by addressing measurement challenges brought up by the

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Sammendrag

Paperet presenterer en metode for hvordan en kan evaluere skattesystemets omfordelende effekt over tid, med basis i individuelle inntektsdata. Metoden baserer seg på at det etableres et felles sammenlikningsgrunnlag som forbedrer mulighetene for å vurdere utviklingen i skattesystemets fordelingseffekt over tid. Metoden gir grunnlag for å identifisere skattepolitikkens rolle for skattesystemets omfordelende effekt. Når denne metoden anvendes med hensyn på det norske skattesystemet før og etter skattereformen i 2006, finner vi at reformen har forbedret den omfordelende effekten. Vi undersøker sensitiviteten av dette resultatet i forhold til alternative inntektsbegrep. Blant annet anvendes et inntektsbegrep som kontrollerer for store "timing-effekter" av utbytteutbetalinger i forbindelse med reformen i 2006.

1. Introduction

Is the tax schedule more redistributive after the Norwegian tax reform of 2006 than prior to the reform? This is a question we shall be able to answer in this paper, using detailed information from micro data.

The Norwegian tax reform of 2006 implied a major revision of the dual income tax system of the 1992 tax reform. A dual income tax system is characterized by separate tax schedules for capital and wage income, and prior to the 2006 reform capital income and wage income were taxed by a (basic) flat rate of 28 percent, whereas a two-tier surtax supplemented the basic rate with respect to wage income. The tax reform of 2006 implied a substantial realignment of dividend income and wage income taxation, as the rates of the surtax schedule are reduced in combination with the introduction of a tax on dividends above a normal rate of return. As income earners at the high end of the scale both are punished by the new tax on dividends but benefit from the reduction in marginal tax rates on wage income, the total distributional effect is genuinely uncertain.

The contribution of this paper consists in suggesting a methodology for evaluation of distributional effects of a tax reform, such as the Norwegian one in 2006, by analyzing cross-sectional micro data over the period 2000–2008. A key characteristic of the present suggestion is that the evaluation strategy is founded on the concept of income redistribution. This means that trends in inequality of pre-tax income is assessed against changes in post-tax income distributions, before and after the tax reform.

Several characteristics of this evaluation approach are worth noting. First of all, the evaluation method is non-welfarist in the sense that characterizations are based on the distribution of income and not based on the utilitarian sum of individual utilities, as the so-called welfarist approach suggests, see Kaplow and Shavell (2002). Next, we find the two-folded informational content, addressing information about both pre-tax and post-tax income distributions (and the difference between them) beneficial for identifying the contribution of tax changes on the income distribution. First, as tax changes work on income distributions both through direct and indirect (behavioral) effects, the identification of behavioral effects of tax changes, such as labor supply effects, gain from addressing information about pre-tax income distributions. Secondly, the focus on the (intermediate) pre-tax income distribution emphasizes that the identification of the working of tax changes may depend on the definition of income. As an example, in this study we draw attention to a measurement challenge, stemming from tax legislation influencing incentives to shift income over time and between tax bases.

In particular, the tax reform evaluated in the present paper changed incentives involved in the decision between paying out dividends and saving in the firm, generating strong timing effects on dividend payout. Instead of measuring the actual income transfers from firms to individuals, which show highly fluctuating patterns due to changing tax laws, as demonstrated by Alstadsæter and Fjærli (2009), a normalized corporate return is calculated and added to pre-tax and post-tax income. Another measurement issue that we address in this study is treatment of income from owner-occupied housing, utilizing new imputed rent data.

Third, the pre-tax income distribution also serves as a foundation for establishing a baseline scenario or a benchmark from which the tax policies can be evaluated. This is arguably the most particular reason for addressing information about pre-tax income distributions when discussing how tax changes affect income distributions and the argument goes as follows: year-specific measures of inequality or redistribution over time provide only very weak identification of the role of tax policies. One may observe that there is more redistribution or that inequality has increased after a reform, but the role of tax policy for outcomes is not identified. As already noted, pre-tax income distributions and the resulting post-tax income schedules are influenced by a number of factors, such as the business cycle, demographical changes, and tax changes. In order to go further in identifying the effect of tax policy changes we apply the so-called "transplant-and-compare" procedure of redistribution, suggested by Dardanoni and Lambert (2002). According to this perspective and methodology, the redistributional effect is measured in terms of a common base or a common reference where measures of redistribution for each year are adjusted for pre-tax income inequality differences between years. Thus, this method holds the promise of getting closer in isolating the policy-makers contribution to redistribution over time. Given that (as already noted) we are able to address the effects of behavioral adjustments on pre-tax income distributions, the "transplant-and-compare" procedure singles out the variation in policymakers' "redistributional efforts" over time. We therefore believe that the "common base" concept for tax policy comparison is highly relevant for evaluation of tax reforms.

There is a huge literature on empirical measurements of distributional effects of tax-benefit reforms, covering a whole range of various methodological approaches. For instance, one line of research uses structural modeling approaches, by employing models that are surveyed in Blundell, MaCurdy and Meghir (2007), whereas others would assess contributions by addressing measures of income inequality and redistribution over time, see for example Jenkins (1995) and Bishop et al. (1997). Recently, we have witnessed increased efforts to establish "benchmark" or "counterfactuals" within the latter type of research (within a fully structural approach these concepts follow more or less

directly), see Kasten, Sammartino and Toder (1994), Clark and Leicester (2004), Thoresen (2004), Lambert and Thoresen (2009), Bargain and Callan (2010). The present paper relates to this part of the literature.

In the following we describe the informational content of our suggestion for identification of tax policy changes: a common base evaluation strategy which controls for different measurement problems (such as timing effects stemming from the shifting of income between personal and corporate tax bases) and labor supply effects. Empirical measures are derived by employing cross-sectional data from several administrative registers over the period 2000–2008. The core is data from the Income Statistics for Households from Statistics Norway (2010a), which contain register-based information on the whole population. To control for the timing effects, we establish a link between results of the firms and the individual share owners. This is done by linking information about profits from the Accounting Statistics for Non-Financial Limited Companies (Statistics Norway, 2010b) to individuals, using the Register of Shareholders (Statistics Norway, 2009a) as the connecting bridge. The pre-tax income distribution changes due to behavioral adjustments because of lower marginal tax rates on wage income are obtained by employing the tax-benefit model system LOTTE (Aasness, Dagsvik and Thoresen, 2007). To predict the labor supply effects of the tax reductions we use the main estimate from Aarbu and Thoresen (2001) and Thoresen, Vattø and Aarbu (2011), who exploit the variation in net-of-tax rates of the 1992 and 2006 tax reforms, respectively, to obtain estimates of the elasticity of taxable income for Norway.

The rest of the paper is organized as follows. In Section 2 we describe the Norwegian tax reform of 2006. Next, in Section 3, we explain in further detail the empirical strategy that we follow. After a short description of data in Section 4, we present the results. Section 5 concludes the paper.

2. The Norwegian tax reform of 2006

Norway has a "dual income tax" system, enacted by the 1992 tax reform[1] which consists of a combination of a low proportional tax rate on capital income and progressive tax rates on labor income. The system proliferated throughout the Nordic countries in the early 1990s. The Norwegian version had a flat 28 percent tax rate levied on corporate income, capital and labor income coupled with a progressive surtax applicable to labor income. Double taxation of dividends was abolished, as taxpayers receiving dividends were given full credit for taxes paid at the corporate level, and the capital gain tax system exempted gains attributable to retained earnings taxed at the corporate level. These separate schedules for capital and labor income created obvious incentives for taxpayers to recharacterize labor income as capital income. To limit such tax avoidance, the 1992 reform introduced the "split model" for the self-employed and closely-held firms (defined as businesses in which more than two-thirds of the shares were owned by the active owner). Rules were established for dividing business income into capital and labor income, and the resulting imputed wage income was subject to a two-tier surtax. The top marginal tax rates for wage earners and owners of small businesses (the self-employed and owners of closely-held firms) were 48.8 percent and 51.7 percent in 1992.[2] Between 1992 and 2004 both the threshold for the second tier of the surtax and marginal rates increased, resulting in the statutory tax rates for 2004 shown in Figure 1. The top marginal statutory tax rate for high income wage earners was 55.3 percent in 2004. The schedule for imputed wage income under the split model (not shown in Figure 1) has a very complicated structure, implying highly non-convex budget sets, with marginal tax rates moving from 52.2 through 49.3, 28, to 55.3 percent, and then back down to 28 percent again as income increases.

The 1990s saw increasing pressure on the dual income tax system, for instance it was apparent that some owners of small firms were able to gain from moving out of the split model, as documented by Thoresen and Alstadsæter (2010). The reform of 2006 emerged as an attempt to create a system that would not enable taxpayers to benefit from the lower flat rate applied to capital income by transforming labor income into capital income; see Sørensen (2005) for the wider background to the reform and steps taken to adjust the dual income tax system.

[1] See Sørensen (1994, 2005), Cnossen (2000), Boadway (2004), and Genser and Reutter (2007) for more on dual income tax systems.

[2] The rates for business owners were higher because social insurance contribution rates were higher, 10.7 percent rather than 7.8 percent. However, under the split model, for imputed wage income above NOK434,000 (USD70,000 according to the exchange rate for 1992), the social security tax goes down to 7.8 percent for business owners as well.

Under the 2006 tax reform, the split model was superseded by rules of a more general nature, with dividends taxed at both the corporate and individual levels, in contrast to the 1992 reform which had only corporate level taxation. The current tax is levied on individual dividend incomes above a rate-of-return allowance, that is, on profits above a risk-free rate of return. Thus, only the equity premium is subject to taxation, by 48.2 percent.[3] The rate of return allowance is determined by the imputation rate and the stepped-up basis for the share, the latter being calculated by the acquisition price and all previous unused rate-of-return allowances.[4]

Top marginal tax rates on wage income were cut to narrow the differences between the marginal tax rates on capital income and labor income. Figure 1 reflects the principal features of the Norwegian labor income tax system: a two-tier surtax that supplements a basic income tax rate of 28 percent plus a 7.8 percent social insurance contribution. In 2004 the first tier of the surtax was applied at approximately NOK380,000 (USD59,200)[5] at a rate of 13.5 percent, and the second tier of 19.5 percent applied to income in excess of approximately NOK970,000 (USD151,100).[6] In the 2006 reform,[7] the maximum marginal tax rate fell from 55.3 to 47.8 percent, but became effective at a lower level of NOK800,000 (USD124,600). To sum up, the reform effected a dramatic realignment of the maximum marginal tax rates on dividend income in excess of the risk-free rate of return and wage income, from 28 and 55.3 percent respectively in 2004, to 48.2 percent and 47.8 percent in 2006. Such cuts might be expected to have substantial labor supply effects, and we will return to this issue in the next section.

In order to mitigate the distributional problems associated with the compression of marginal tax rates on wage income, the government increased the wage income standard deduction, which is constructed by multiplying wage income by a factor (equal to 24 percent in 2004) subject to a maximum (NOK50,780 or USD7,900, in 2004, in terms of wage-adjusted 2006 kroner). In 2006 the multiplicative factor increased to 34 percent, and the maximum deduction increased to NOK61,100 (USD9,500).

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[3] The figure for the marginal tax rate on dividends in 2006 is derived as follows. Capital income is taxed at a 28 percent rate at the corporate level, and the remaining 72 percent is transferred to the individual and taxed at 28 percent (above the rate of return allowance), resulting in a combined rate of 20.16 percent (0.72x0.28), which is then added to the corporate level rate.

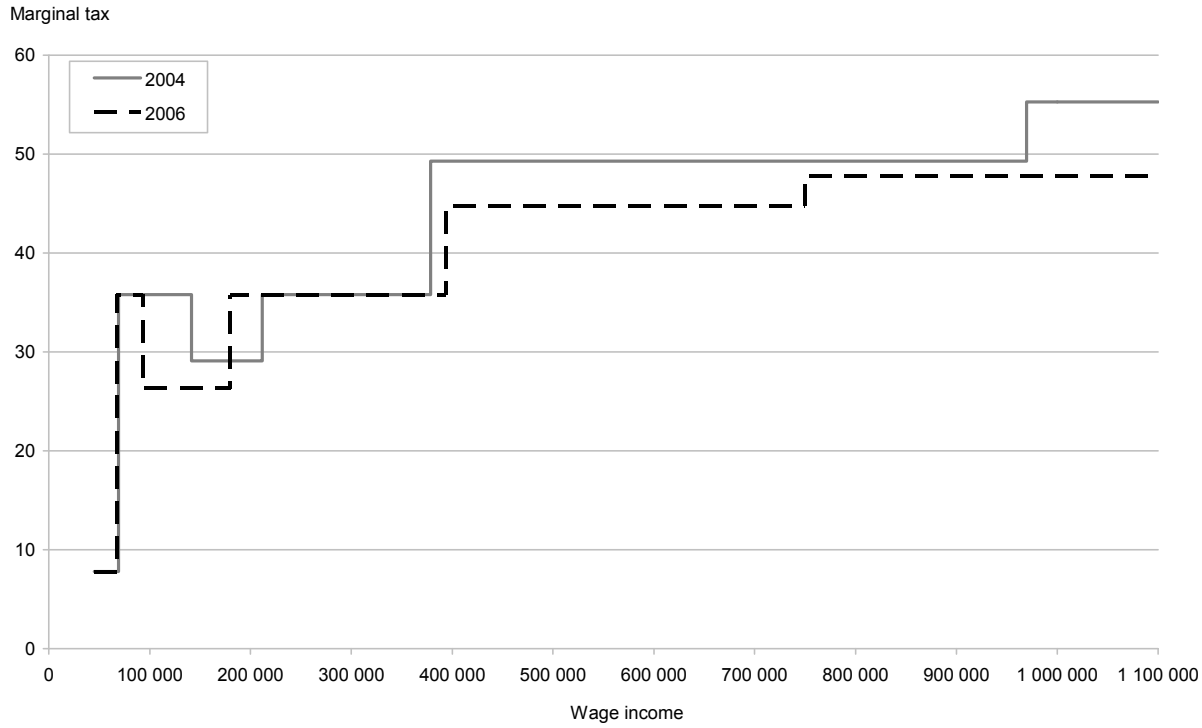
[4] Note that there was a temporary tax on dividends in 2001, which influences redistributional effect patterns of the period under consideration, 2000–2008. The dividend tax schedule of 2001 was somewhat different, compared to the system introduced by the 2006 tax reform: 11 percent tax above a threshold.

[5] We use an exchange rate of one U.S. dollar for 6.418 Norwegian kroner (NOK), the average exchange rate in 2006.

[6] All thresholds are adjusted to 2006 levels.

[7] The changes were phased in during 2005, which explains why 2004 represents the pre-reform year.

Figure 1. Statutory Marginal Tax Rates on Wage Income, 2004 and 2006. All Thresholds Adjusted to 2006 Level (1US$=NOK6.418)



There were some other changes in the income tax as well. For instance, the tax on income generated by owner-occupied homes was phased out. This was paralleled by increased wealth taxation of homes, basically derived by increasing house values by 25 percent (the valuation is based on a separate valuation system and not on market values). Changes in the wealth taxation are reflected by measures of post-tax income. Further, with respect to other tax bases, the general VAT rate increased from 24 to 25 percent and the lower VAT rate on food from 12 to 13. However, even though effects through indirect taxation very straightforwardly can be included in the empirical approach, as seen in Nygård and Thoresen (2009), we restrict our attention to effects of changes in the personal income tax; the main reason is that the changes in the indirect taxation have very small effects.[8]

As these components of the reform are expected to gain different parts of the income distribution, the total redistributional effect is hard to determine without a closer empirical examination. In the rest of the paper we present a method to measure overall redistributional effects of tax reforms.

[8] Changes in indirect taxes are often seen as ”blunt instruments” for redistribution, as noted by Stern (1990) and Creedy (2003).

3. A "common base" evaluation strategy for the measurement of tax policy effects

3.1 The transplant and compare procedure

A welfarist approach to tax reform would be founded on aggregations of after-tax well-being (utility) across the population, see the presentation and argumentation in Kaplow and Shavell (2002).[9] There are well-known applied approaches for evaluation of policy changes in terms of utility instead of income, see suggestion for measures in terms of money metric utility in King (1983). However, given the ambition of a comprehensive evaluation, there are practical constraints involved. For instance, the development of realistic (utilitarian) decision models for all the different groups of the population is rather demanding and information intensive.[10] Although it can be argued that using an income based welfare metric does not solve this informational problem, as income is an insufficient indicator of well-being (Sen, 1997), it is nevertheless a key concept for decision-makers' social evaluation.

The present approach suggests evaluating policy changes by studying measures of redistribution over time, which we will show is useful in order to establish a common reference for which different tax schedules can be evaluated. However, even though measures of overall welfare effects will not be presented here, it is worth noting that the present framework also can be expressed in terms of a social welfare metric, a so-called abbreviated social welfare function (Lambert, 1993; Creedy, 1996). Lambert (1993) shows that the welfare premium associated with a tax change can be measured assessing the performance of the (new) tax relative to the (new) equal yield proportional tax, in comparison with the performance of the old tax relative to the old equal yield proportional tax.[11]

Another limitation of the present analysis is it's partial nature. The tax incidence approach, as for instance put forward by Pechman and Okner (1974), reminds us that the burden of the tax may fall upon someone else than the people actually paying the tax. Even though one can think of employees

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[9] Similar views have been expressed by contributors to the Mirrlees review, see Banks and Diamond (2010). Some authors, as Feldstein (1976) and Rosen (1978), suggest taking horizontal equity considerations into account within a utilitarian approach, which implies that some normative significance is also given to a hypothetical no-tax alternative (measured in utility).

[10] For instance, we could have used the model presented in Dagsvik and Jia (2010) in combination with the approach suggested in Dagsvik and Karlstrøm (2005) to obtain money metric utility measures of distributional effects with respect to wage earners. However, given the ambition of an overall assessment, we would need realistic models for a number of other groups as well.

[11] Departing from the following abbreviated form of the welfare premium (λ): $\lambda = (1-at)\overline{n}\Pi_R$, where *at* is the average tax rate, $\overline{n}$ is the average post-tax income and Π_R is the measure of redistribution. Usually, mean income is held fixed, irrespective of whether the old or the new tax schedule is in place; this issue will be further discussed when measuring tax redistribution below.

for instance being able to pass on increased taxes to employers, the personal income tax is normally assumed to be born by the people on whom the tax is initially levied. Accordingly, the present analysis will basically follow this assumption. However, as already noted, special attention is given to the distinction between corporate and individual income, as there is evidence of substantial income shifting between corporate and personal tax bases over time. We will return to this issue shortly.

Distributional effects of the steps that have been taken in order to balance the budget, i.e., distributional effects of the expenditure side, are not brought into the analysis. This is in contrast to the evaluation procedure suggested by Elmendorf et al. (2008) for evaluation of the 2001 and 2003 US tax cuts. The main reason for neglecting effects of the expenditure side is that the reform is mainly a shift towards more dividend taxation and less tax on wage income, with only small effects on overall revenue. Total costs are estimated at NOK9.3 billion, which was 0.43 percent of GDP and 1.29 percent of total mainland tax revenue in 2006 (Thoresen, Aasness and Jia, 2010). Moreover, the reform can be seen as funded by borrowing against future income, transferring money from the Norwegian Petroleum Fund, a fund based on Norwegian oil wealth; generating unclear distributional effects (at least in a cross-sectional perspective).

Let us probe deeper into the concept of "redistributional effects", before explaining the establishment of a baseline for identification of tax policy effects. If *x* and *n* are individual pre-tax and post-tax incomes, respectively, the pre-tax income distribution is symbolized by *F(x)*, and post-tax or net income is defined by $N(x) = x - T(x)$, where *T(x)* is the tax schedule. The pair $\langle N, F \rangle$, comprising the net income schedule (*N*) and the pre-tax income distribution (*F*) , determines the redistributive effects. An example of further description, which we will use in the following, is to establish a Gini based measure of redistribution, such as the Reynolds-Smolensky index of redistribution (Reynolds and Smolensky, 1977), $\Pi_R = G_X - G_N$, where G_X and G_N are Gini coefficients for the pre-tax and post-tax income, respectively. A standard way to describe the redistributional effects of the tax system over time is to present year-specific measures of redistribution over a time period.

Instead of addressing information about post-tax income inequality directly, as often seen in over time evaluations of income distributions, the focus on the pair $\langle N, F \rangle$ signifies that the final outcome (*N*) results from the policy-maker's efforts to redistribute market generated income (*F*) into a welfare maximizing schedule. From a tax policy evaluation perspective we find this methodological approach beneficial, as it denotes the importance of income definitions, it is helpful for identification of behavioral effects and it provides an opportunity to establish a common reference from which the

policy-makers' redistributional efforts over time can be assessed. Let us first address the establishment of a baseline, and return to the two other issues below.

Obviously, from a policymaking perspective it is of key interest to pin down the specific effects of tax policies *per se* on the observed outcomes. The literature has offered some suggestions to obtain more detailed information on tax policy effects, and two such contributions are the approaches proposed by Kasten, Sammartino and Toder (1994) and Dardanoni and Lambert (2002). Both methods can be seen as establishing a "common base" for identification of the tax policy contribution, founded on the utilization of pre-tax income distributions and differences between them. Kasten et al. suggest identifying effects of tax policy changes through what we characterize as a "fixed-income" approach, which means that pre-tax income distributions are kept fixed, a base year being chosen and exposed to taxation as per the various tax schemes of the period. Using this method for evaluation of the 2006 tax reform, a relevant comparison is between $\langle N_{2006}, F_{2006} \rangle$ and a simulation where the 2004 tax schedule is inflated to 2006 and applied on 2006 incomes, symbolized by $\left\langle N_{2004}^{p^{06}}, F_{2006} \right\rangle$, where the superscript p^{06} indicates that the post-tax income schedule of 2004 is projected to 2006.
According to Lambert and Thoresen (2009) the "fixed-income" approach may be vulnerable to base dependence problems, i.e. results will differ depending whether one adjusts the 2004 tax schedule to 2006 and uses the 2006 income distribution as base for the comparison or deflates the 2006 tax schedule to 2004 and employs the 2004 schedule as the base for comparison. Lambert and Thoresen (2009) find that the procedure suggested by Dardanoni and Lambert (2002) performs better in that respect. Dardanoni and Lambert propose to compare post-tax distributions that have been adjusted to a common base regime, in which differences in pre-tax income inequality have been controlled for through a "transplant-and-compare" procedure. The pre-tax income distributions are turned into a common base, indicated by the subscript *C* of F_C, and the relevant comparison for the period 2000–2008 is now founded on the following pairs: $\left\langle N_{2000}^{g^{C00}}, F_C \right\rangle$, $\left\langle N_{2001}^{g^{C01}}, F_C \right\rangle$,…, $\left\langle N_{2008}^{g^{C08}}, F_C \right\rangle$, where the superscripts g^{C00}, g^{C01},…, g^{C08} indicate that post-tax income schedules have been deformed by fitted deformation functions, reflecting the pre-tax income distribution differences between the actual distribution and the common base.

The reasoning behind the use and the practical implementation of the deformation functions can briefly be explained by the following. Let *F(x)* be the distribution function for pre-tax income for a given year, and let *u = u(x)* be some attribute of a person or household having *x* before tax. If *g(x)* is a

mapping of pre-tax incomes into $\mathbb{R}^+$, the conjugate mapping $u^g(x) = g(u(g^{-1}(x)))$, i.e. $u^g = g \circ u \circ g^{-1}$, operates on the distribution $F \circ g^{-1}$. If an isoelastic function *g(x)* can be found such that $F \circ g^{-1}$ is the standard lognormal distribution, call this ln(0,1),[12] then as Dardanoni and Lambert (2002) have shown, the conjugate of the pre-tax/post-tax income mapping $x \to n$ can be regarded as the transplant of the tax system into ln(0,1) . This can be done with the data of each year, to enable a set of comparisons, of the actions of transplants upon ln(0,1), in which actual tax schedules have all been adjusted for pre-tax distributional differences. In fact, whenever pre-tax income distributions differ in logarithms only by location and scale, and not only in the lognormal case, an appropriate reference distribution can be selected, and the comparisons made with tax systems that have been adjusted for over time differences in pre-tax location and scale. Empirically, one wants to find that, for each year *t*, there exist a_t and $b_t > 0$ such that the distribution of $a_t + b_t \ln(x)$ is sufficiently close to the chosen reference distribution, where *x* is pre-tax income. Thus, the method implies finding estimates of a_t and b_t that minimize the differences between the two distributions in terms of location and scale. This corresponds to finding the intercept and slope in a traditional OLS regression, and the R^2 statistic becomes the relevant measure of goodness-of-fit. The post-tax income values are then adjusted by the fitted deformation function $g_t(x) = e^{a_t} x^{b_t}$ before making comparisons of redistributive effect.

In practice, either the reference distribution holds high or low pre-tax income inequality ($b > 1$ or $b < 1$), the transformation into common base comparisons will narrow the spread in redistribution, compared to the standard year-specific approach, as the deformation function works harder on the pre-tax income distribution than on the post-tax income distribution.

3.2 Measurement challenges in reform periods: timing effects

Having established a baseline for identification of tax policy changes, a valid identification strategy must also address key characteristics of tax reforms, such as behavioral responses. It is widely accepted that tax changes influence behavior along several dimensions; see the three-tier behavioral response hierarchy by Slemrod (1992; 1995), under which real responses are the most sluggish, timing is the most responsive, and the third component, avoidance behavior, is somewhere in the middle. Fiscal manipulation in the form of income shifting has received much attention and takes different

[12] That is to say, $y \sim \ln(0,1) \Leftrightarrow \ln(y) \sim N(0,1)$, where $N(0,1)$ is the standard normal distribution.

forms. For instance, Gordon and Slemrod (2000) discuss the changes in organizational form following the US Tax Reform Act of 1986 and implications for interpretations of responses to the reform. The Norwegian tax reform of 2006, which was announced several years in advance, introduced incentives to step up dividends prior to the reform. Indeed, this caused strong timing effects, see Alstadsæter and Fjærli (2009).[13] In Figure 2, we show the amount of dividend payments to households over the period 2000–2008. Dividend payments dropped in 2001 due to a temporary tax on dividends, and then rose steadily from 2002 and on, after the appointment of a government tax commission with the mandate to consider a new tax on dividends. Most of these extraordinary dividends were immediately reshuffled into the corporations as "new" equity or loans from the owners, and thus represented only formal transactions with the single purpose to convert retained profits into contributed equity or debt, which can be returned tax-exempt to the owners despite the presence of a future dividend tax. Alstadsæter and Fjærli (2009) show that the increase in dividends was accompanied by a corresponding increase in the debt-equity ratios and in the ratios of contributed equity. Thus, the hike in dividends prior to the implementation of the reform did not necessarily have a counterpart in increased corporate income. This demonstrates that descriptions of distributional effects which do not address the measurement problem related to timing effects are in danger of giving a misleading picture of the underlying distribution of economic resources in the population.

For example, official income statistics (Statistics Norway, 2010a) show that while inequality measured by the Gini coefficient was fairly stable around 0.23–0.24 from 1995 and on, it rose to 0.26 in 2000 (prior to the temporary and pre-announced dividend tax of 2001). Inequality fell back to 0.23 in 2002, then rose steadily and reached a peak of 0.33 in 2005, and finally dropped to 0.24 in 2006. The ratio of the share of income held by the top 20 percent compared to the bottom 80 percent shows a similar pattern, closely related to the time profile of aggregate dividends displayed in Figure 2.

In order to obtain a concept of income that is more robust against timing effects in the reported income, we calculate a new shareholder income measure by assigning to the owners their entitlement to after-tax profits of the firm, rather than using the traditional income concept based on households' dividends and net capital gains. The basic procedure is straightforward: we simply multiply after-tax profit by the individual ownership shares, using a shareholder register that comprises ownership data for all corporations and individual owners, see Statistics Norway (2009a).

[13] Kari, Karikallio and Pirttilä (2009) find similar results prior to the introduction of a pre-announced dividend tax in Finland.

Next, we need to calculate the tax on this imputed return. The increase in tax revenue from the shareholder income tax so far seems modest, which has to do with the sharp decline in dividends paid after the reform. The retention of profit within the firms (which we allocate to the owners using our alternative concept of income) will generate a corresponding tax upon future distribution. In order to calculate net after-tax shareholder income, this tax has to be estimated by its present value and amortized and converted into an annual amount before subtracting it from gross income. In the actual shareholder model of the present tax schedule, this is a rather complex task, as amounts below the rate of return allowance (RRA) will generate a tax credit by carry forwards of unused RRA's with interest added. However, Sørensen (2005) demonstrates that the present value of the stream of after-tax dividends does not depend on its time profile, if the RRA is properly calculated. Moreover, Fjærli and Raknerud (2009) show that if we let T_t denote the actual tax liability under the shareholder model under actual payout policy, r the interest rate, τ the tax rate, S the base for the calculation of RRA and π the after-tax profit, then, provided that any negative tax base will give a negative tax in any termination period t, we have that

$$(1+r)^{-t}T_t + (1+r)^{-t+1}T_{t-1} + \ldots + (1+r)^{-1}T_1 = (1+r)^{-t}\tau(\pi_t - rS_t) + \ldots + (1+r)^{-1}\tau(\pi_1 - rS_1).$$

Based on this result, our procedure of imputing shareholder income y for individual i at time t is: $y_{it} = \gamma_{ikt}\pi_{kt-1}$, for $t < 2006$, where γ_{ikt} denotes the ownership share of individual i in corporation k in income year t, entitling him to a share of the profit (π) earned in accounting year *t-1*,[14] and $y_{it} = (1-\tau)(\gamma_{ikt}\pi_{kt-1} - rS_{t-1}) + rS_{t-1}$ for $t \geq 2006$. γ and π are imputed based on information from the Accounting Statistics for Non-Financial Limited Companies (Statistics Norway, 2010b) linked to individuals by using the Register of Shareholders (Statistics Norway, 2009a), and then added up for all firms in the portfolio of individual *i*. *rS* is obtained from individual tax returns and includes the RRA for the entire portfolio. At $t \geq 2006$, y is taxed at the flat rate of 28 percent, and a negative tax base will give a negative tax, provided that total net income is positive.[15] This is in line with the normal treatment of negative income from self-employment and unlimited businesses.

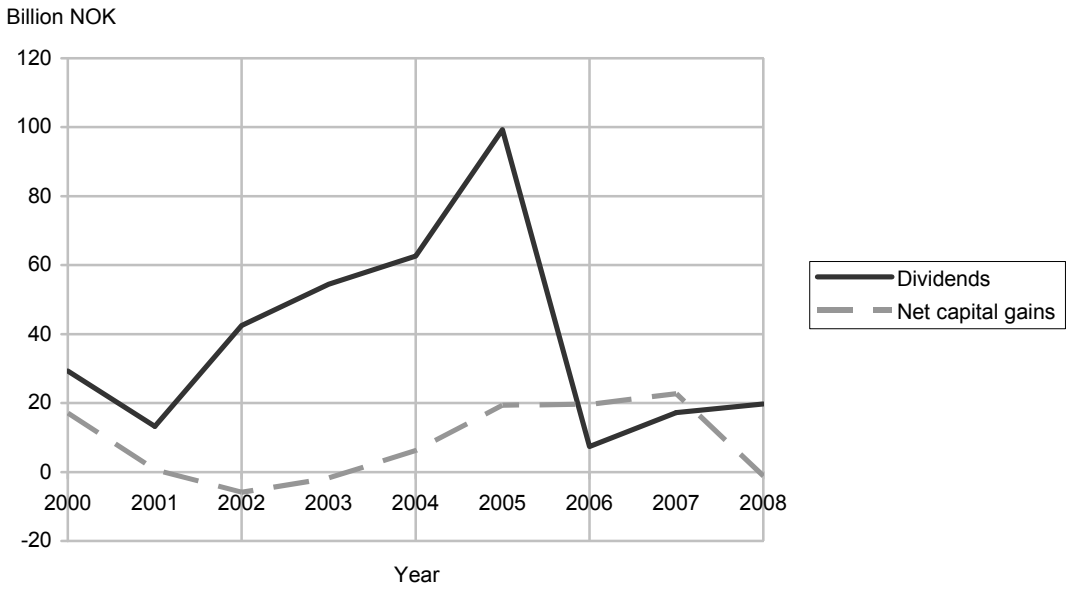
Conceptually in terms of a "common base" evaluation this extension does not alter the main framework. The new pairs employed in the over time evaluation can be seen as, $\left\langle \left(N^*\right)_{2000}^{g^{C00^*}}, F_C^* \right\rangle$

[14] y is tax exempt at the individual level.

[15] The need to limit total net income to the positive domain is purely of technical consideration for calculation of measures of redistribution.

$\left\langle \left(N^*\right)_{2001}^{g^{C01^*}}, F_C^* \right\rangle, \ldots, \left\langle \left(N^*\right)_{2008}^{g^{C08^*}}, F_C^* \right\rangle$, where the symbol * indicates that this approach differs from the standard "common base" evaluation of Section 3.1 because of three modifications: the imputation of profits from the corporate sector changes the pre-tax income distribution, because the tax is calculated on basis of the new imputed income; the post-tax income schedule is changed; and finally, the (empirical) deformation functions also differ as they are based on new pre-tax income distributions.

Figure 2. Development in dividends and net capital gains, 2000–2008



3.3. Imputed income from owner-occupied housing

Another measurement issue that often attracts concern is the calculation of income from housing, see e.g., Frick, Goebel and Grabka (2007). Let us also therefore briefly explain the method that is used to impute income from owner-occupied housing; more details are provided in the appendix. There are three common approaches to imputing income from owner-occupied housing; rental equivalence, user-cost or capital market approach, and out-of-pocket expenses. The latter demands observations of the actual outlays on housing, which is usually found in consumer expenditure surveys. Since this is not the kind of data that we have, the two relevant approaches are the rental equivalence method and the user-cost, or capital market, approach. The rental equivalence method is based on regression models that have rent as the dependent variable and housing characteristics as the right hand side variables. As Røed Larsen (2009) has shown, the number of square meters and area of residence are the two most

important characteristics, so that a rough measure of imputed rent can be obtained on the basis of these two variables alone.

The user cost associated with homeownership is the sum of forgone interest income, property taxes, a risk premium for housing investments, maintenance and depreciation costs, less the owner's nominal capital gain. Since in equilibrium, the user cost of housing should equal the income from housing, the user cost can thus be taken as a measure of imputed income from housing. However, unless one has information about actual maintenance and depreciation costs and so on, there are many parameters that need to be given imputed values.

The capital market approach is based on the same type of reasoning, but is simpler to employ. The starting point is the alternative use of capital in the capital market. Application of the capital market approach is often founded on the current market value of owner-occupied housing, *H*, and outstanding mortgages, *M*, which needs to be deducted from the estimated market value. The implicit rate of return will equal a safe market rate of return on an equal value of investment. Instead of applying a nominal interest rate to total net home value ($H - M$), the nominal interest rate may be applied to the outstanding mortgage (in our data the actual nominal interest paid is directly measured), while the calculation of the return on investment in housing needs to consider that inflation is included in the nominal house value appreciation. Then it may be more appropriate to apply a real interest rate to the dwelling's current market value, i.e., $rH - lM$, where *r* is the real and *l* is the nominal interest rate. A problem with this approach is that it does not take into account any potential depreciation of the building.

In our imputation we have used two alternative rates of return, one is a stable rate of return of 3 percent, which is a middle value of those found in the literature, see Saunders et al. (1992) and Frick, Goebel and Grabka (2007). The other is a floating real rate of return, measured as the money market rate minus inflation. However, as the results for the two different assumptions regarding rates of return are rather similar, we will only present results for the stable 3 percent rate of return.

Since 2005 Statistics Norway has developed estimates for market values of houses based on regression methods, see Statistics Norway (2009b). Since these procedures differ somewhat from year to year, we have used the joint information from all years to determine the approximate size of the house in square meters. This variable has then been multiplied by the area (at city or municipality level) and a dwelling-specific house price to provide a consistent measure of market value over time. For the years

before 2005, housing values have been imputed backwards using the information about size and house prices for families who according to their tax values for housing appear to have remained in the same dwelling over time.

Official income statistics from Statistics Norway for post-tax incomes have not controlled for interest rate expenses, mostly due to the lack of realistic estimates of the return from housing. Now, having established a broader income measure, these expenses are deducted. In terms of the common base approach, the house income extension is conceptually equal to the inclusion of incomes from firms, see Section 3.2.

3.4. Changes in marginal tax rates influence the pre-tax income distribution

Changes in marginal tax rates on wage income will affect the pre-tax income distribution, meaning that changes in the tax schedule generating post-tax income (N) influence the pre-tax distribution function F. Ignoring behavioral effects may conceal important contributions. Such effects are reflected by the distribution function F, but the effects are not explicitly identified, as pre-tax incomes are influenced by a number of factors, such as demographical changes, cyclical effects, developments in transfers and pensions, etc. The following describes how the behavioral adjustments are identified and brought into consideration within a "common base" framework.

There are different ways to isolate the contribution from labor supply adjustments and other adjustments, due to the reduced taxation. For instance, the labor supply module of the tax-benefit model system LOTTE (Aasness, Dagsvik and Thoresen, 2007) can be used to predict effects on working hours and incomes, as done when discussing revenue costs of the reform in Thoresen, Aasness and Jia (2010).

An alternative procedure is employed here, based on utilizing results from Aarbu and Thoresen (2001) and Thoresen, Vattø and Aarbu (2011) in combination with the non-behavioral tax-benefit routine of the LOTTE model system. The tax-benefit model is employed to calculate post-tax income under two different conditions: in the first alternative incomes in 2004 (pre-reform)[16] are projected to 2006 and taxed according to 2006 tax-laws, whereas in the second alternative incomes are not only projected to 2006, they are also adjusted in accordance with predicted responses, represented by the elasticities derived by Aarbu and Thoresen (2001) and Thoresen, Vattø and Aarbu (2011). They estimate taxable income and earned income elasticities with respect to the net-of-tax rate (1 minus the marginal tax

[16] Remember that 2005 was a middle year when marginal tax rate reductions were phased in.

rate), based on income data. This measure is therefore a broader measure of behavioral response to tax changes than working hours alone (Feldstein, 1995). The variation in marginal tax rates along the income scale due to the 1992 and 2006 reforms, respectively, is exploited for estimation of elasticities. Estimates are derived for different subgroups and different specifications; here we use an elasticity estimate of 0.2, which is one of the main estimates of Aarbu and Thoresen (2001). We also assess results for a low-response alternative of 0.1, since the results of Thoresen, Vattø and Aarbu seem to indicate a lower response, and a high-response alternative of 0.3, which is more in accordance with results of the international literature within this field; see the survey by Saez, Slemrod and Giertz (2009). Figure 1 shows the net-of-tax rate changes for different income groups, which, when multiplied by the overall elasticity estimate, determines the income growth rates that are entered into the tax-benefit model.

As the behavioral effects already are included in the pre-tax income distributions, the conceptual exposition of this tax policy contribution deviates from the description seen so far. In terms of a standard (non-common-base) comparison, we depart from an income distribution not infected by behavioral responses, i.e., the 2004 pre-tax income distribution, where the individual position in the distribution of wage income defines the net-of-tax rate change and the following wage response induced wage growth. The two pairs of measures of redistributional effects are both based on 2004 incomes being projected to 2006 and exposed to the 2006 tax schedule; the only difference between them is the behavioral response that are used to establish the pre-tax income distribution, symbolized by λ, which also influences the post-tax income schedule, as denoted by the superscript (N_{2006}^{λ}): $\left\langle N_{2006}, F_{2004}^{p^{06}} \right\rangle$ and $\left\langle N_{2006}^{\lambda}, F_{2004}^{\lambda p^{06}} \right\rangle$. The identification of the contribution from behavioral responses is simply the difference between the pairs: $\left\langle N_{2006}^{\lambda}, F_{2004}^{\lambda p^{06}} \right\rangle - \left\langle N_{2006}, F_{2004}^{p^{06}} \right\rangle$.

Moreover, this can be turned into a "common base" comparison by a deformation based on the differences between $F_{2004}^{\lambda p^{06}}$ and $F_{2004}^{p^{06}}$, which means that the relevant common base measure is $\left\langle \left(N_{2006}^{\lambda} \right)^{g^{\lambda}}, F_C \right\rangle - \left\langle N_{2006}, F_C \right\rangle$, where the deformation function g^{λ} reflects the difference between the pre-tax income distributions due to behavioral responses, as denoted by the superscript λ. The determination of the deformation function is based on identifying location and scale parameters, as already described (in Section 3.1).

4. Is the tax schedule more redistributive after the reform?

4.1 Data

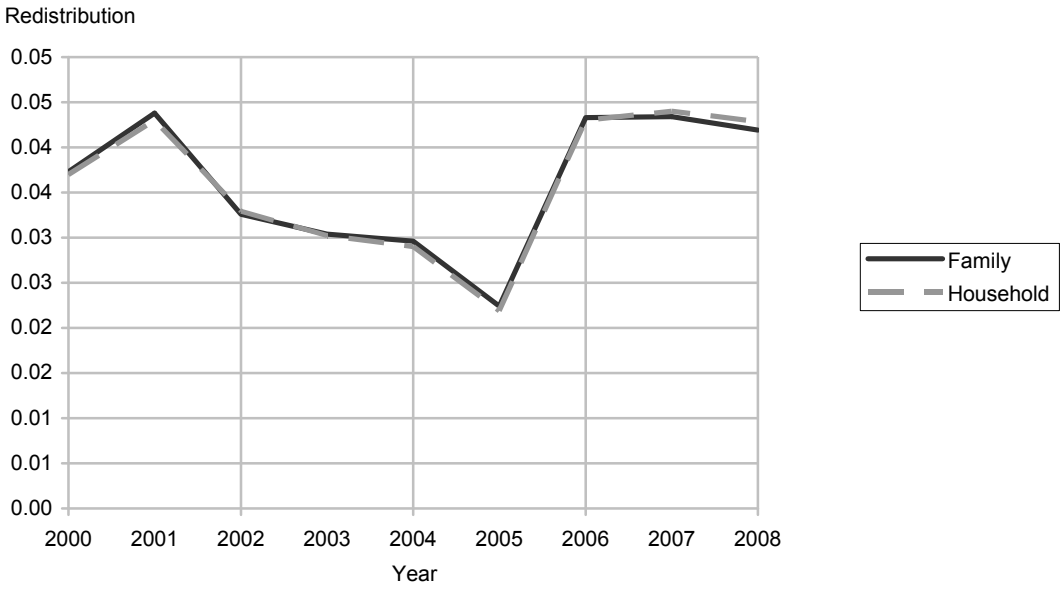
The primary source of data for this study is the Income Statistics for Households (Statistics Norway, 2010a). These statistics hold register-based information on the whole population, derived primarily from information retrieved from all income tax returns in the Directorate of Taxes' Register of Personal Taxpayers, but also from other administrative registers, such as data from the Labour and Welfare Organisation. The Income Statistics for Households succeeded the Income Statistics for Persons and Families recently, when household data were obtained from registers too, with the establishment of the Ground Parcel, Address and Building Register in 2004 (Statistics Norway, 2009b). Prior to that information about household income were obtained through a sample survey, as households were interviewed about household composition.

The household is often considered as the basic economic unit for decisions and allocations concerning distributional aspects, but for the purpose of this study, covering the time period 2000–2008, the data limitations mean that we only have register-based household information for all Norwegians for the latter part of the time span. As it is preferable to have data for the whole population throughout the period, income at the family level is used as the main measure. However, as shown by Figure 3, the description of redistributional effects (as measured by the Reynolds-Smolensky index) 2000–2008 does not depend on which data source is applied, as the characterization is similar, independent of whether sample survey household data or register-based family data are used. Note that in Figure 3 and in all the preceding presentations of results incomes are measured in "equivalent values", which means that the nominal values of aggregate income of the household or family have been weighted by an equivalence scale (the square root of the number of household/family members). The representation of each household/family when obtaining summary measures of redistributional effects depends on the number of household/family members; this is often characterized as employing the individual as the unit of analysis. Thus, incomes have been readjusted for interpersonal comparison similarly to what Ebert (1997) denotes as Method 3.

A main reason for the preference for register data is that they alleviate a broad connection to firm data. As denoted, an important ambition of the present analysis is to control for the timing effects influencing dividend payouts, which means that information on firm results must be linked to individuals in some way. Here this is achieved by connecting information about profits from the Accounting Statistics for Non-Financial Limited Companies (Statistics Norway, 2010b) to individuals,

using the Register of Shareholders (Statistics Norway, 2009a) as the bridge between firms and individual owners.

Figure 3. Redistributional effect (Reynolds-Smolensky index), 2000–2008. Descriptions based on family and household data



The tax-benefit model LOTTE (Aasness, Dagsvik and Thoresen, 2007), which is applied to derive estimates for the contribution from behavioral adjustments, uses the Income Statistics for Households as the main data source, and there is close correspondence between tax simulation results and actual tax payments, as they are recorded in data.

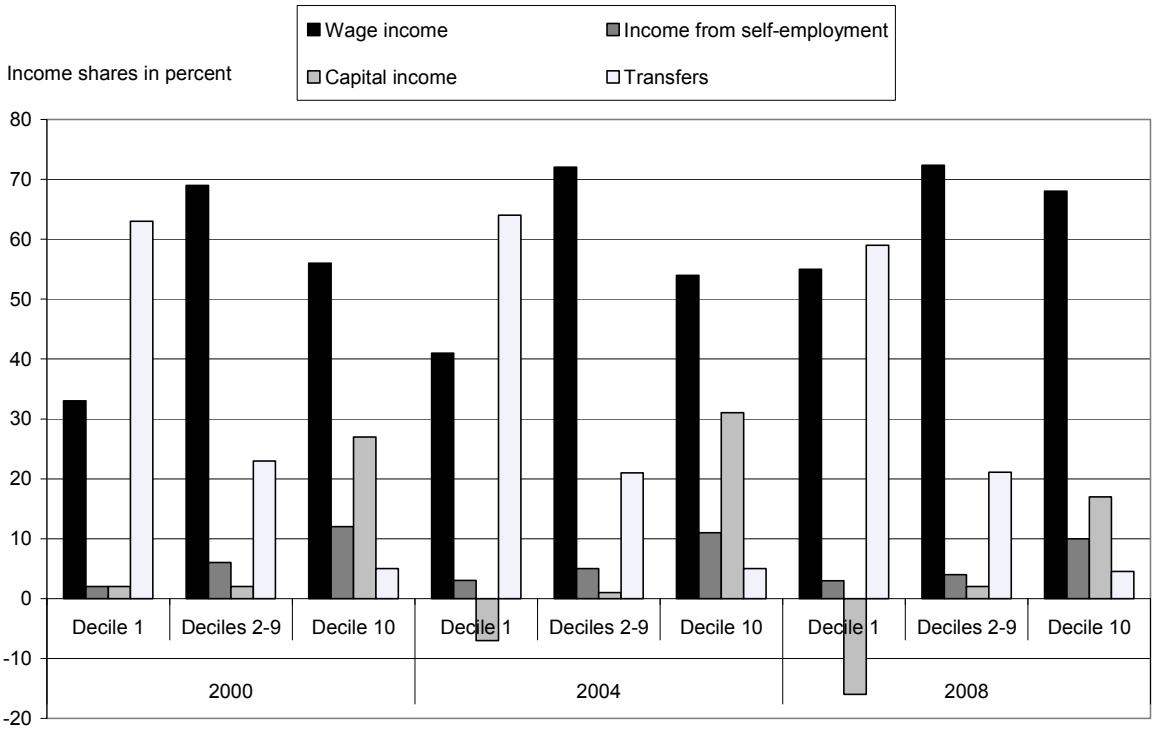
4.3 Redistribution 2000–2008 by year-specific measures

Before presenting the results of the common base approach, let us first address measures of redistribution over time in a traditional form, i.e., in terms of measures of redistribution where inequality of pre-tax and post-tax income have been calculated separately for each year, to obtain year-specific measures of redistribution, as measured by the Reynolds-Smolensky index (see Section 3.1). Results will be shown for different definitions of pre-tax income and post-tax income schedules.

If we depart from a "narrow definition" of income, as used when presenting official estimates of income inequality in Norway, see Statistics Norway (2010a), Figure 4 forms the background for what we observe in terms of redistributional effects. In order to relate income component changes over time to effects on income distributions, in Figure 4 we describe income factor shares for decile 1, deciles 2–9

and decile 10, for three years of the period of analysis. Note that individuals are ranked by (equivalent) post-tax income, whereas income shares refer to components of total pre-tax income. The figure clearly shows the changing significance of capital income (which includes dividends as a major component) for persons in decile 10 over time, increasing to over 30 percent in 2004, followed by a substantial reduction in 2008, down to approximately 17 percent after the introduction of tax on dividends at the individual level. It also belongs to this picture that dividend income is an income component that almost exclusively benefits people at the high end of the income distribution; for example 95 percent of dividends were received by individuals in decile 10 in 2004. We also see that the reduction in capital income in decile 10 is counteracted by increased wage income share after the reform.

Figure 4. Income shares of pre-tax income when individuals are ranked by post-tax (equivalized) household income, in 2000, 2004 and 2008.

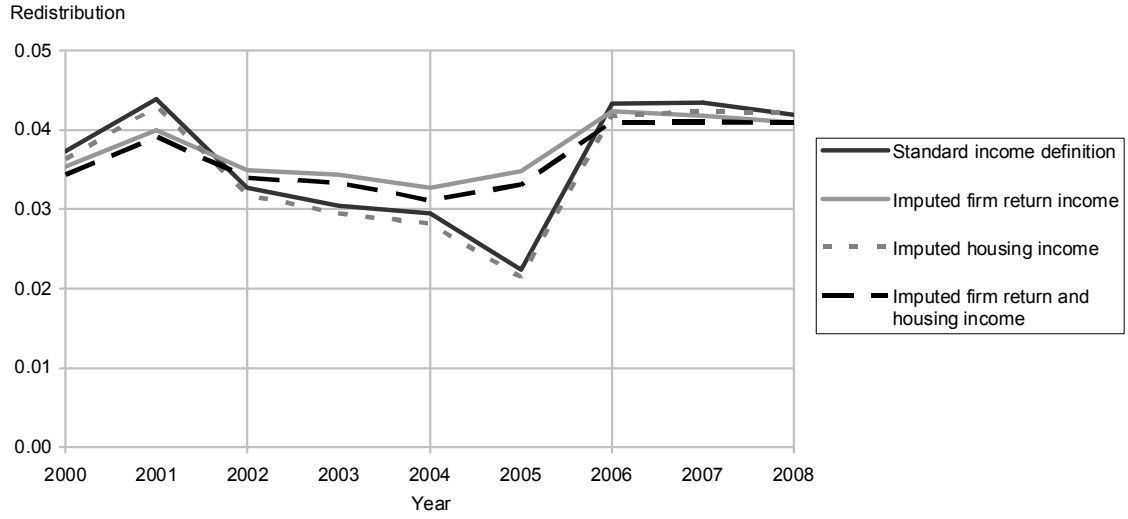


In Figure 5 this pattern is reflected by the depiction of redistributional effects according to the standard definition of income.[17] After the 2006 tax reform there is less dividends transferred to households, which is signified by a compression of pre-tax income. Further, as the pre-tax income inequality reduction is not counteracted by disproportional reductions in post-tax income, which would have happened if the transfer had been taxed before the reform, this effect is carried over to a substantial

[17] Since data cover the whole population, note that neither in connection to the results of Figure 5 nor in the following we present estimates for standard errors.

reduction in post-tax income inequality, also assisted by the tax on dividends after the reform (even though this latter is small, as the tax base have been eroded; see Figure 2). The tax relief on high wage income (compare Figure 1 for rate reductions), is not strong enough to neutralize this effect. Remember also that the reform implied increases in wage income standard deductions, which improves the tax system's redistributional effects.

Figure 5. Redistributional effect (Reynolds-Smolensky index) 2000–2008, measured by four definitions of income



The measures of redistribution for alternative definitions of income basically show the same development over the time period, as for the standard income definition. This is shown in Figure 5 for three alternatives: an alternative where actual dividends and capital gains are replaced by calculated ownership returns, an income concept with imputed income from housing, and a third alternative, which combines the two extensions. However, when firm profit is imputed to the owners, and taxed by approximately 48 percent over a normal rate of return after the reform, the increase in redistribution result lead to similar results for a different reason: now the increased taxation of dividends after the reform is the main explanation (and not the reduction in dividends as is the case for the standard income definition).

Another complication when measuring tax policy effects, the behavioral effect of tax changes, will be discussed in terms of "common base" results shortly.

4.4 Common base results

The description of redistribution in Figure 5 is restricted in the sense that the identification of the tax policy contribution to the observed redistributional effect is hard to seize. In order to establish a common

baseline from which the policymakers' tax redistributional efforts to the results can be evaluated, we show results for a "common base" evaluation (Dardanoni and Lambert, 2002) of the reform.[18] Thus, a number of regressions have been carried out, randomly picking year 2000 as the base year.[19] After controlling the post-tax schedules for the fitted deformations (see Section 3 for further description), we obtain a common base evaluation of the time period, described in Figure 6, for four definitions of income (corresponding to Figure 5). Compared to the results of Figure 5, the normalizations reduce the redistributional effects in years with higher pre-tax income distributions, as the non-equiproportionate compression reduces the pre-tax income distribution more than the post-tax income schedule. However, given that the variation in the inequality of pre-tax income distribution is limited over the (narrow) time period under investigation, the results are rather similar to the results for the year-specific measures.

The "common base" evaluations of Figure 6 clearly suggest that the tax reform of 2006 improved the redistributional effects of the personal income tax. Independent of the choice of income definition, we see that the tax schedule is more redistributive after the reform. For instance, the redistributional effect of the tax system is approximately 15 percent higher in 2008 than in 2000 according to the wider definition of income (including imputed firm returns and housing income). Similar to the results of Figure 5, the explanation to the increased redistribution after the reform depends on the definition of income: for the standard income definition the main reason is the reduction in dividend payments, whereas for income definitions involving imputed firm returns it is the (latent) taxation of dividends which drives results.

Moreover, given that the ambition of the present analysis is to identify the effects of tax policy changes, we have also calculated how the income adjustments due to the reduced marginal tax rates have influenced the evaluation of common base redistributional efforts. As this effect is "hidden" in the pre-tax income distribution, it is identified by applying three alternative tax behavioral estimates fed into a tax-benefit model calculation; see further details in Section 3. As expected, this effect has little influence on the overall tax redistribution. Effects are strongest for the largest elasticity estimate, 0.3, but even for that alternative the overall redistributional effect in 2006[20] is reduced by less that 0.2 percent. There are several reasons for this rather small effect: firstly, the additional income increases due to the responses are modest, secondly, the income growth starts at median income levels; at NOK380,000 or USD59,000 (see Figure 1 for schedule changes), and thirdly, even though the top

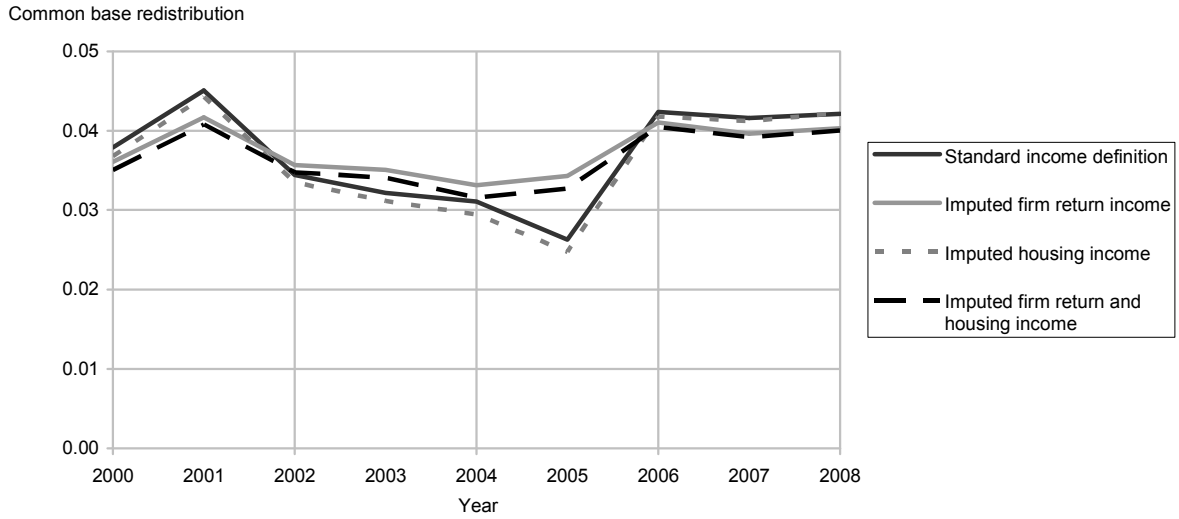
[18] An alternative would be to employ a "fixed income" procedure along the lines of Kasten, Sammartino and Toder (1994) and Thoresen (2004).

[19] The findings of Lambert and Thoresen (2009) suggest that this method provides results that (for practical purposes) are independent of the choice of base.

[20] Similar calculations could have been done with respect to the two other post-reform years. However, as tax schedules are unaltered, this would not add anything to the main finding.

marginal tax rates have been reduced, there is still significant progression working through the sur-tax system which dampens the effect from pre-tax income growth on post-tax income distributions.

Figure 6. Common base redistributional effect (Reynolds-Smolensky index) 2000–2008, measured by four definitions of income



5. Conclusion

In this paper we show how the question "is a tax schedule more redistributive after a reform?" can be answered with the use of different sources of micro data. Given that the ambition is to single out the contribution of tax policies *per se*, a "common base" procedure is applied. When applying this methodological framework on data before and after the Norwegian tax reform of 2006, we find that the reform has improved the tax schedule's redistributive effect. This main conclusion survives for alternative definitions of income, for instance controlling for timing effects and behavioral responses to the reform. Thus, the 2006 reform represents an improvement in redistributional efforts.

Even though a rather comprehensive evaluation strategy is lined out here, there are important shortcomings. For instance, the present analysis is partial in the sense that important interactions are neglected. However, as we so far only have data for a few years after the reform, we must assume that general equilibrium effects are more important in a longer time perspective.

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Appendix: More detailed descriptions of imputation methods

Imputed returns

The rate of return allowance, *RRA*, is based on the simple principle that the shareholder can deduct an amount corresponding to the risk free return of the share's acquisition cost. However, the practical implementation of the system is more complex. In the first year, the RRA equals the risk-free return, *r*, on the cost of acquisition, S_1: $RRA_1 = rS_1$. The tax liability on dividends received in period *t*, D_t, is $T_t = \tau \max\left(0, D_t - RRA_t\right)$. The *RRA* will evolve according to a difference equation, until the end of the period (Ω):

(A1) $$RRA_t = rS_1 + (1+r)\max(0, RRA_{t-1} - D_{t-1}) \quad t = 2,3,...,\Omega \ ,$$

i.e., current *RRA* is the sum of the risk free return on the cost price and the previous period's unused *RRA*, with interests added. The calculation of the tax liability in any given period requires information on the unused *RRA*, which in turn will affect future tax liabilities. Since we want to treat individuals equally and independent of when shareholder income is realized, we need to calculate the present value equivalent of the future tax liabilities related to current profit (which can be distributed now or in the future, and can be realized as dividends or capital gains). To do this, we utilize the fact that the *RRA* shields the risk free return from taxation regardless of *when* shareholder income is realized. For example, if all profits are retained by the firm until the termination period Ω, i.e., $D_t = 0$, for $t = 1,2,...,\Omega - 1$, the *RRA* in the termination period is $RRA_\Omega = r\left[(1+r)-1\right]S_1$, i.e., equal to the accumulated interest of an initial investment in government bonds of S_1 in period 1. Also, since corporate profit or loss, π, will manifest as dividends plus capital gains over the horizon $t = 1,2,...,\Omega$, we have for any number of periods *t* that the present value of the tax liabilities of the shareholders in a firm that is 100 percent owned by domestic individuals is equal to the present value of the accounting profits minus the rate of return allowance earned in period *t*:

(A2) $$\left(1+r\right)^{-t} T_t + \left(1+r\right)^{-t+1} T_{t-1} + ... + \left(1+r\right)^{-1} T_1 = \left(1+r\right)^{-t} \tau\left(\pi_t - rS_t\right) + ... + \left(1+r\right)^{-1} \tau(\pi_1 - rS_1) \ .$$

Based on this result, our procedure of imputing shareholder income *y* for individual *i* in period *t* is:

$y_{it} = \sum_{k=1}^{K} \gamma_{ikt} \pi_{kt-1}$, for $t < 2006$, and $y_{it} = (1-\tau)(\sum_{k=1}^{K} \gamma_{ikt} \pi_{kt-1} - rS_{t-1}) + rS_{t-1}$, for $t \geq 2006$. $\gamma_{ikt} = \frac{n_{ikt}}{N_{kt}}$,

where n_{ikt} is individual *i*'s number of shares in firm *k* in period *t* and N_{kt} is the total number of shares in

firm *k* in period *t*. S_{t-1} is the ingoing base for the *RRA* in the period *t* tax base, for all shares in the taxpayer's portfolio, and π_{t-1} denotes corporate profit (or loss) after interest and corporate taxes in period $t-1$. Thus, γ_{ikt} denotes the ownership share of individual *i* in corporation *k* in the income year *t*, entitling him to a share of the profit (π) earned in the accounting year *t-1*. Profits and ownership shares are calculated on the bases of information from the Accounting Statistics for Non-Financial Limited Companies (Statistics Norway, 2010b) and the Register of Shareholders (Statistics Norway, 2009a), and then added up for all firms in the portfolio of taxpayer *i*. The risk-free return of the share's acquisition cost, *rS*, is obtained from individual tax returns and includes the RRA for the entire portfolio.

Imputed income from owner-occupied housing returns

The capital market approach to imputation of income from owner-occupied housing is based on the current market value of owner-occupied housing, *H*, and outstanding mortgages, *M*, which needs to be deducted from the estimated market value. The implicit rate of return will equal a safe market rate of return on an equal value of investment. Instead of applying a nominal interest rate to total net home value (*H-M*), the nominal interest rate may be applied to the outstanding mortgage while the calculation of the return on investment in housing needs to consider that inflation is included in the nominal house value appreciation, such that it may be more appropriate to apply a real interest rate to the dwelling's current market value, $i_h = rH - lM$, where *r* is a real rate of return, *H* is the nominal value of housing, *l* is the nominal mortgage interest rate, and *M* is the remaining mortgage. In our imputation we have used a stable real rate of return of 3 per cent. Three percent can be considered a middle value of those found in the literature, see Saunders et al. (1992) and Frick, Goebel and Grabka (2007). For comparison, we tried a floating real rate of return, measured as the money market rate minus inflation. This alternative did not give a very different overall result, and since fluctuations in house prices is incorporated in the nominal housing value and floating interest rates are predominant in the mortgage markets, we argue that the expected return from housing should be a stable (long run) rate of return.

Current market value has been measured and included in the register data for the years 2005–2008. Since the introduction of market value for housing in the data, the procedure has been under constant revision. So, first of all we use the market values to obtain the size of the dwelling and then impute new market values using the size in square meter times the area specific price per square meters. Furthermore, we impute market values for the years before 2005 using the same method as long as the family has reported some tax value for housing.

If the size of the dwelling in 2005 differs very much from later years, we assume that the family has lived in a 2005-sized dwelling in the years before; else if the size of the house is the same over the years 2005–2008, we assume that the family has lived in this house also before 2005. Table A.1 shows that this procedure results in a decline in the number of observations for whom we have imputed income from housing in the early years of the period, but also that the reduction is not very large.

In our data, interest paid on debt is directly measured in the tax returns, thus lM is taken from directly the data and not imputed. The drawback with this procedure is that this variable includes interest on all debt, not only mortgages. In other words, it includes also interest paid on loans for consumer durables, secondary housing, and even consumer credit. While investment in business capital yields a corresponding income stream, investment in consumer capital other than housing is not represented with a corresponding income stream in our data. As a result, net income from housing will be underestimated for families with large interest payments on durables.

Table A.1. Means of imputed income and debt (in NOK), 2000–2008

	Imputed income (3% rate of return)	Interest paid on total debt	Number of observations/families
2000	27,040	23,750	2,283,668
2001	28,510	28,460	2,305,855
2002	30,120	30,360	2,330,447
2003	30,470	27,350	2,353,218
2004	34,140	20,720	2,378,652
2005	36,710	21,870	2,411,102
2006	38,730	26,220	2,404,076
2007	42,600	36,700	2,456,491
2008	45,710	55,200	2,254,562