Discussion Papers No. 545, May 2008
Statistics Norway, Research Department

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More realistic estimates of revenue changes from tax cuts

Abstract:
Procedures of revenue estimation of changes in the personal income tax are discussed. Using revenue estimates of the 2006 tax cuts in the personal income tax in Norway as an example, we show that estimates of costs of cuts differ substantially when different effects are brought into consideration. Estimates of revenue effects which take labor supply responses and effects through indirect taxation and corporate taxes into account are presented and contrasted with estimates obtained by current procedures. Our estimates indicate that a substantial part of the initial outlay is returned; approximately 56 percent comes back as increased tax revenues from other tax bases and increased personal income tax following from labor supply adjustments.

Keywords: tax revenue estimates, scoring procedures, microsimulation

JEL classification: H24; H31

Acknowledgement: We would like to thank Kirsten Hansen for her assistance in the preparation of this study and Erling Holmøy for comments on an earlier version of the paper. Comments from participants at the 8th Nordic Seminar of Microsimulation Models, June 8-9, 2006, Oslo, and at a seminar at the Tax Policy Department at the Ministry of Finance, September 13, 2007, are appreciated.

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1. Introduction

Revenue estimation practice in the U.S. has recently attracted widespread attention; a selection of papers include Diamond and Moomau (2003), Altshuler et al. (2005), Auerbach (2005), Carroll and Hrung (2005), Page (2005), Diamond (2005), Gale and Orszag (2005), Mankiw and Weinzierl (2006). In the present paper we discuss tax revenue estimation and present estimates of revenue effects of the 2006 change in Norway's personal income tax, contrasting estimates based on current non-behavioral methods with estimates that reflect that tax changes induce behavioral effects and generate effects from other tax bases.

Whereas the discussion in the U.S. case primarily concerns integrating dynamic, macroeconomic effects into revenue estimates, because of the ten-year budgeting period, the focus here is on revenue estimates for the next fiscal year. As in the U.S., see e.g., Auerbach (2005), current procedures of revenue projections in Norway can be categorized as 1) forecasts of revenues based on current policy, employing macro models and other types of information; and 2) predictions of revenue effects from suggested tax changes. In U.S. terminology, the first type is called *baseline*, the second *scoring*. We suggest that Norwegian scoring procedures could be improved. Firstly, they largely neglect the repercussions of changes in the personal income tax on behavior; secondly, they do not take into account the effect changes in the personal income tax can have on revenues from other tax bases, such as revenues from indirect and corporate taxes. In practical terms, it means that the budgets Parliament usually passes will be based on biased information of revenue effects, as decisions are based on estimates of changes in revenue that are not the expected ones. The practice came under particular scrutiny during work on drafting the last Norwegian reform of the personal income tax, i.e., the 2006 tax reform. The reform involved substantial tax reductions, and the difference between cost measures with and without behavioral effects was expected to be large. In particular the political parties in favor of deeper tax cuts commented on the absence of information on supply side effects in the revenue estimates, causing the revenue loss of the reform to be overestimated (Innst.S.nr.232 2003-2004).

The main contribution of this paper comes from quantifying the deviation between estimates according to current practice and more ambitious methods, using the changes actuated by the 2006 tax reform as an example. When the personal income tax is reduced, as was the case in 2005 and 2006, rising post-tax income (for given pre-tax income) induces increased consumption, producing in consequence revenue from indirect tax bases. Moreover, the tax reductions influence labor supply incentives, resulting in increased personal income tax revenue through increased pre-tax incomes. The

rise in pre-tax income affects in turn the payroll tax levied on employers. And as pre-tax income rises, post-tax income and consumption rise too, leading to a new effect through indirect tax revenues.

The present paper provides estimates of magnitudes of the various effects involved, i.e., of behavioral effects and interactions with other tax bases. By summarizing them, we are able to compare aggregate measures following from this more ambitious approach to tax revenue estimation to "current practice" estimates. In this sense this paper also presents an estimate of the degree of self-financing of tax cuts, as discussed by, e.g., Lindsey (1987); Feldstein (1995); Mankiw and Weinzierl (2006), and illustrated by the famous Laffer curve.

Methodologically, we rely on estimates based on micro data, using simulation models that are established in order to predict effects of tax changes. The personal income tax module, LOTTE-Skatt, which is part of the Norwegian tax-benefit model system LOTTE (Aasness, Dagsvik and Thoresen, 2007), was established precisely to calculate revenue effects and distributional effects of changes in the personal income tax. This module, combined with various macroeconomic projection procedures, is used to define baseline revenue estimates in the Norwegian system. With respect to scoring, the LOTTE-Skatt module provides revenue estimates that ignore important behavioral responses to tax rate changes, such as labor supply adjustments. To assess effects on labor supply of changes in the personal income tax, a new module was therefore constructed, known as LOTTE-Arbeid, and based on Dagsvik and Jia (2006). Estimates of changes in indirect tax revenue caused by changes in a detailed consumption vector with different tax rates are provided by the model KONSUM (Nygård and Aasness, 2003) with a complete demand system, which is also connected to Statistics Norway's macroeconomic models, the macroeconometric model MODAG (Boug et al., 2002) and the CGE model MSG (Heide et al., 2004).

The plan of the paper is as follows. In section 2 we discuss the current Norwegian system for calculating tax revenues in light of procedures in the U.S. Section 3 presents tax revenue estimates of the 2006 Norwegian tax reform as produced by this method. The tax reform resulted in loss of revenue, among other things because of lower marginal tax rates at high income levels. However, this estimate does not take into account that people usually work more to lower taxes, and in Section 4 we provide tax revenue estimates generated from labor supply adjustments to the new schedule, including effect through revenue from the payroll tax. In Section 5 we explore the interaction between changes in the personal income tax and revenues from other tax bases and present estimates of increases in indirect tax revenues. Section 6 summarizes results.

2. Current practice of scoring procedures

Auerbach (2005) provides an outline of the pros and cons of dynamic scoring. Obviously, ignoring dynamic scoring could entail biased revenue estimates as important effects are neglected. It has also been argued that such procedures are politically biased, as tax cuts of the type we are considering here are seen as more costly than they really are. However, as noted by Gale and Orszag (2005), tax cuts do not necessarily lead to increased national income (and thereby increased revenues). Results may for instance depend on how the government closes the budget deficit, e.g., whether the initial reduction in revenue is matched by a reduction in government consumption.[1] Arguments against dynamic scoring involve substantial uncertainty about effects and that methodological assumptions might be due to political pressure.

The U.S. scoring procedure discussion is reflective of the U.S. system's longer planning horizons. Nevertheless, while the revenue estimates we have in mind here may be more short-sighted, we still have challenges to overcome regarding the selection of effects to be included in the scoring procedures. We have seen some efforts to systematize the effects. According to Slemrod's three-tier behavioral response hierarchy (Slemrod 1992; 1995), the real responses are the most sluggish, timing the most responsive, with the third component, avoidance behavior, somewhere in the middle. Any behavioral response to taxation can therefore be classified on the basis of timing (or not) and reflection (or not) of tax avoidance or real behavior. Gravelle (1995) uses three categories to systematize responses: microeconomic effects and macroeconomic effects, where the latter is divided into two; cyclical effects, for instance arising from an underemployed economy; and more permanent effects that increase or decrease productive resources (labor and capital). Microeconomic effects include behavioral responses affecting the allocation of consumption or investment, and changes in timing and type of income received. In terms of Slemrod's and Gravelle's categorization schemes, the present paper focuses on real effects or permanent macroeconomic effects, such as labor supply effects, though the increase in consumption tax revenues following from increased post-tax income is considered a non-real microeconomic effect. Creedy and Duncan (2005) operate with first, second and third round effects of policy changes. The first round relates to fixed hours; the second to changes in desired hours of work; while third round effects allow for wage rate changes. The latter type of effects, often characterized as feedback effects, will not be considered here. Our main concern is with the difference between first and second round effects.[2]

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[1] For diverging views on effects of U.S. tax reforms, see Diamond (2005); Gale and Orszag (2005).

[2] Note also the literature on analytical expressions for tax revenue responsiveness, closely related to the topic of this paper; see e.g., Hutton and Lambert (1980), Creedy and Gemmell (1995).

Another distinction often appearing in the scoring literature is that between static and dynamic scoring. The analysis here belongs to a static approach in the sense that we employ cross-sectional information, discuss short-term revenue effects, and insofar as we want to detract from (dynamic) general equilibrium effects. This does not mean that we do not take behavioral changes into account, as estimates reflecting labor supply effects are presented; the labor supply microsimulations also exhibiting the heterogenous behavior of economic agents. Other behavioral effects, such as effects on investment decisions, are however not considered. In the case of labor supply adjustments, it can be argued that tax-payers take time to adjust to new schedules, and the demand side's capacity to absorb changes can also be questioned. In this sense we measure effects in the first year that might not appear until later.

The Norwegian revenue estimation system is similar to the U.S. system as there is more than one agency involved. In the U.S., the Congressional Budget Office, see e.g., CBO (2006), provides baseline revenue estimates for 10-year periods, based on the most recent budgetary decisions and macroeconomic projections. Members of U.S. Congress derive forecasts of revenue effects from tax-law changes by the Joint Committee on Taxation, see e.g., JCT (2005). JCT use several microsimulation models to estimate revenue impact of changes in tax-laws. These revenue estimates bring in some behavioral effects of the tax changes. For instance, if a proposed tax schedule involves a change in the realization rate for capital gains, it is assumed that the tax-payers will change their timing of realizations. Similarly, when there are alterations in marginal tax rates, tax-payers are expected to change the form and the timing of income. However, tax revenues are unaffected by macroeconomic feedback effects as it is normally assumed that total income (or GNP) and other macroeconomic factors remain unchanged. This has caused some concern, and both JCT and CBO have recently produced more dynamic analyses of budget proposals, see CBO (2003) and JCT (2003). We also note the plans to create a dynamic analysis division within the Office of Tax Analysis in the U.S. Department of the Treasury (OTA, 2006).

In Norway the involved agencies are the Ministry of Finance and Statistics Norway. The projection period is usually shorter compared to the U.S., with the main focus being revenue of the coming year's budget. One of the prime means of estimating revenue changes in the personal income tax in Norway is provided by the non-behavioral tax-benefit model LOTTE-Skatt (Aasness, Dagsvik and Thoresen, 2007). The model derives its data mainly from individual income tax returns. In order to project data to the year of interest, macroeconomic forecasts on key parameters are employed, including interest rate, the degree of unemployment, capital income growth, wage growth, etc. These predictions are partly derived from macroeconomic model simulations, produced by the MODAG model (Boug et al., 2002), developed by Statistics Norway and operated both by the Ministry of

Finance and Statistics Norway. Some of the capital income components – dividends, capital gains and interest expenses/incomes – are particularly difficult to project. The revenue according to the existing tax schedule is derived by a simulation where the current tax rule is applied to these data. For instance, when the lawmakers prepared the 2008 budget, they took the 2007 tax-law projected to 2008 as their point of reference. It was their baseline.

Next, the government establishes a budget proposal, the estimates of personal income tax revenue changes being largely derived from a non-behavioral LOTTE-Skatt simulation. This is scoring, according to U.S. terminology. However, model simulations will fail to pick up certain new tax rule changes. They are usually addressed outside the model. For instance, if a new savings scheme is launched which makes the tax-payer eligible for a tax credit, the revenue effect will depend on the take-up ratio of this scheme. It is usually the Ministry of Finance that comes up with these additional revenue change estimates by addressing information from other data sources. Such effects belong to what Gravelle (1995) terms microeconomic effects, and will be brought into consideration in discussions of alternative schedules suggested, for instance, by the Parliamentary opposition. It is the lack of precise information or realistic behavioral models that prevents us from addressing numerous microeconomic effects, such as income shifting and timing of income, in a more formal and precise manner. According to Slemrod's behavioral response hierarchy (Slemrod, 1992; 1995), real effects, such as consumption and labor supply, are less elastic than timing responses and income shifting activities. However, as many tax-payers are unlikely to have wide opportunities to shift income, it will probably reduce the significance of such effects on revenues.

Some important induced effects are obviously left out, something certain sections of Parliament have criticized (Innst.S.nr.232 2003-2004). Revenue estimates do not control for changes in indirect taxation that come from changes in disposable income, and scoring procedures do not capture labor supply effects. Still, in the Norwegian context and from a practitioners' viewpoint, current procedures may have offered a practical framework for budget deliberations. It is because we now have access to more accurate information on behavioral effects and tax simulation tools of greater sophistication that we can begin to reconsider current procedures. In the next section we show revenue estimates produced by current procedures; the rest of the paper is devoted to discussing the effects of employing more ambitious scoring procedures.

3. The Norwegian tax reform of 2006: revenue effects according to current procedures

We employ tax revenue effects of the 2006 tax reform in order to discuss effects of different scoring procedures. As the tax reform was phased during 2005 and 2006, we compare revenues according to

the 2004 and 2006 schedules. The reform was considered necessary to address certain effects of the 1992 dual income tax system. For instance, there was a desire to limit incentives for shifting income into capital income to benefit from the lower rate. Successful businesses found it advantageous to move out of the so-called split model, originally developed to divide business income between capital income and labor income for self-employed and owners of closely held firms; see Sørensen (2005) for the wider background to the reform and steps taken to adjust the dual income tax system, and Thoresen and Alstadsæter (2008) for empirical evidence on income shifting activities.

One important change provided for taxation of dividends both at the corporate and individual level in the new system. The 1992 reform involved only corporate level taxation. The tax on dividends is levied on incomes above a rate of return allowance.[3] Obviously, this tax change influences behavior; whereas about 60 billion Norwegian kroner (NOK), corresponding to about 9.75 billion U.S. dollars,[4] was transferred to Norwegian households in 2004, prior to the reform, the estimates for 2006 was NOK18 billion (US$ 2.9 billion). This estimate, provided by the Ministry of Finance, includes timing effects, i.e., dividends were increased prior to the shareholder tax.[5] Further, the dividend tax for 2006 was estimated at NOK 3.5–4 billion, including effects of increased capital gains taxation, which are taxed according to the same principles.

The new tax reform replaces the split model with a more general regulation: profit above a risk free rate of return is taxed according to a schedule very similar to that applied to wage income; see description of 2006 schedule in Figure 1. The social insurance contribution rate is higher for the self-employed: 10.7 percent as against 7.8 for wage earners.

Marginal tax rates on capital income and labor income also converged by reducing marginal tax rates on wages. This is shown in Figure 1. The Norwegian surtax system consists of two tiers on top of the basic tax rate at 28 percent and the social insurance contribution rate at 7.8 percent. In 2004 the former kicked in at approximately NOK380,000 at the rate of 13.5 percent, and the latter (19.5 percent) at approximately NOK970,000.[6] Figure 1 demonstrates the effect of the reform on thresholds and rates. The maximum marginal tax rate fell from 55.3 to 47.8 percent, but starts working at a lower level, i.e., NOK800,000. To sum up, the reform effected a dramatic realignment of

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[3] Which means that the tax is levied on profit above a risk free rate of return.

[4] 1 US dollar (US$) equalled 6.418 Norwegian kroner (NOK) on average in 2006. We use this exchange rate here and throughout the paper.

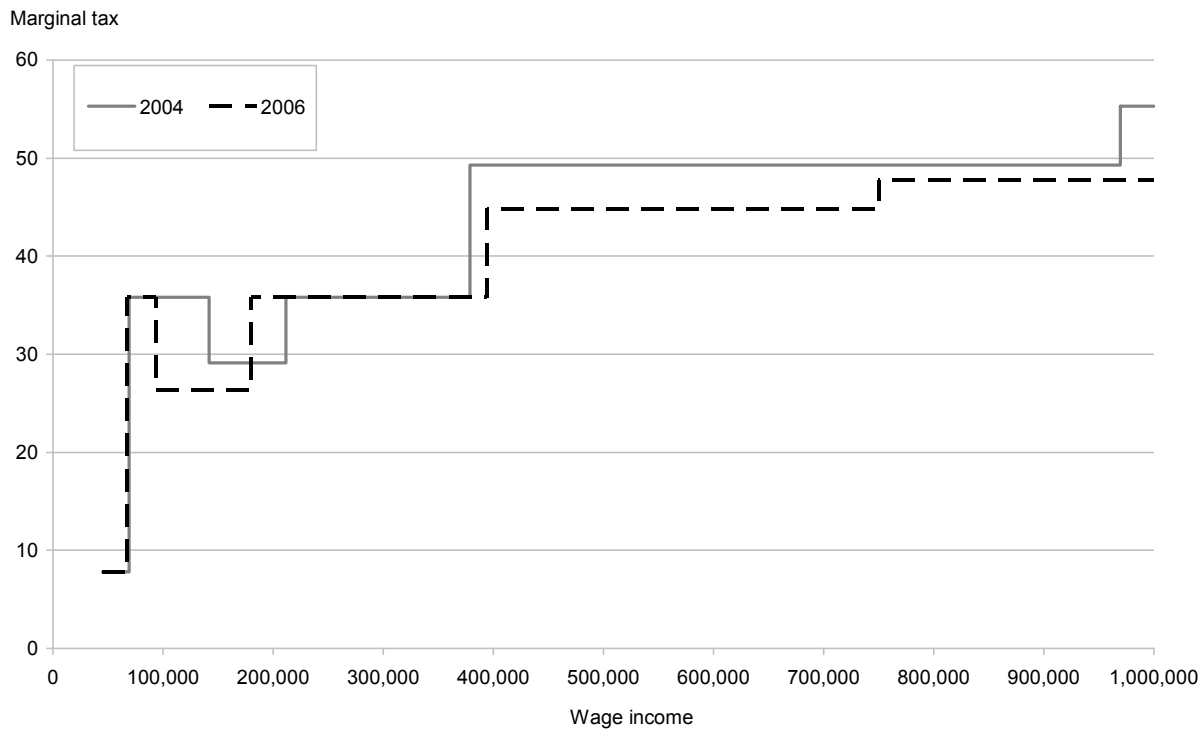
[5] This example also highlights the importance of focusing on different tax bases simultaneously: the reduction in dividends will be reflected by increases in retained earnings. A non-symmetrical tax treatment of incomes at the individual and the corporate level may induce revenue effects from such behavioral changes.

[6] All thresholds are adjusted to 2006 levels to make them comparable.

maximum marginal tax rates on capital income and wage income: from 28 and 55.3 percent respectively in 2004, to 48.2 and 47.8 percent in 2006.[7]

In order to ease distributional effects, the wage income standard deduction was increased. It is constructed by multiplying wage income by a rate (24 percent in 2004) and constrained by a maximum amount (NOK50,780 in 2004 in terms of wage adjusted 2006 kroner). In 2006 the rate went up to 34 percent, and maximum deduction to NOK61,100. There were some other changes as well, among them, tax on income generated by owner-occupied homes was phased out.

Figure 1. Marginal tax rates on wage income, 2004 and 2006. All thresholds adjusted to 2006 level



Before presenting revenue estimates as produced by current procedures, we should explain the notation. *R* symbolizes revenue. As this paper seeks to highlight the importance of including effects on various tax bases, we keep them separate by introducing *iR* for revenues from tax base $i : i \in \{PI, CORP, IND\}$, where *PIR* is revenue from personal income taxes, *CORPR* symbolizes

[7] The figure for marginal capital tax in 2006 is derived as follows: capital is taxed by 28 percent at the corporate level, the rest (72 percent) being transferred to the individual and taxed by 28 at the margin (above the rate of return allowance): 72 percent multiplied by 0.28 gives 20.16 percent, which is added to the corporate level rate.

revenue from the corporate income tax, while *INDR* is revenue from indirect taxes.[8] Thus, we employ the notation iR_j, where we let subscript *j* indicate the effects included in revenue estimates: $j \in \{N, L\}$, where *N* refers to revenue estimates without behavioral effects, i.e., the form of the estimate generated by the tax-benefit model LOTTE-Skatt for the personal income tax; *L* indicates incorporation of labor supply effects. A standard revenue estimate from the (non-behavioral) LOTTE-Skatt is symbolized by PIR_N.

Let us consider estimates of revenue costs of the reform according to prevailing administrative procedures. Table 1 presents revenue estimates for the personal income tax, as derived from a simulation of the tax-benefit model LOTTE-Skatt, comparing 2004 and 2006 schedules. Before adding the effects of consumption and labor supply, the overall cost of the reform is estimated to be NOK8.3 billion (US$1.29 billion), with a reduction in total tax burden for wage earners slightly in excess of NOK8.6 billion (US$1.34 billion).

Table 1. Personal income tax: estimates of total tax revenues and revenue changes from the 2006 reform. Results from tax-benefit model LOTTE-Skatt, in million NOK*

2004 rules applied to 2006: PIR_N	2006 rules applied to 2006: PIR_N	Revenue change: ΔPIR_N	
		For all tax-payers	For wage earners
248,346	240,047	-8,299	-8,578

*1US$=NOK6.418 according to 2006 exchange rates.

4. Labor supply effects

As already noted above, current tax policy simulation procedures ignore labor supply effects. Many contributions to the literature attest to significant labor supply responses with respect to changes in wages and taxes, see for example the survey by Blundell and MaCurdy (1999). With respect to the example employed in the current paper, if we ignore labor supply effects of taxation, the revenue loss is exaggerated, as emphasized by the Laffer curve reasoning. In this section we discuss the effect on revenues of including labor supply effects for the wage earners, by applying the sub-module LOTTE-Arbeid of the LOTTE model system (Aasness, Dagsvik and Thoresen, 2007).[9]

The module includes separately estimated labor supply models for married/cohabiting, single males and single females, based on a particular discrete choice framework developed by

[8] This list of tax bases is not complete; for instance personal wealth taxes are included in *PIR* while revenue from the inheritance tax is not.

[9] Carroll and Hrung (2005) argue that estimates of the taxable income elasticity are relevant in this context, as they reflect a broad range of responses to tax changes. Instead of using a labor simulation model, we could have used the main estimate in Aarbu and Thoresen (2001) along the same lines as seen in Carroll and Hrung (2005).

Dagsvik (1994). Insofar as it gives fundamental importance to the notion of *job choice* the approach differs from standard discrete choice models of labor supply. Specifically, workers are assumed to have preferences over a latent worker-specific choice set of jobs from which they choose their most preferred job. A job is characterized by fixed (job-specific) working hours and other non-pecuniary attributes. As a result, observed hours of work is interpreted as the job-specific (fixed) hours of work associated with the chosen job. This modeling approach has been used in a number of applications, most recently by Dagsvik and Strøm (2006). We explain the model further in the Appendix, but see Dagsvik and Jia (2006) for detailed setup and estimates of the model.

Three versions of the model are estimated on a sample of Norwegian microdata from 1997: a joint model for married couples and two separate models for single females and males. Aggregate wage elasticities are calculated for all model versions, see the Appendix. The elasticities indicate a moderately elastic labor supply for married females, but less elastic for males and single females, consonant with the main findings in the literature, see Blundell and MaCurdy (1999). The overall wage elasticities are 0.6 and 0.004 for married/cohabiting and single females, respectively, and estimates for married/cohabiting and single males 0.08 and 0.03 respectively. These average estimates do not differ much from corresponding elasticities estimated on another Norwegian dataset from 1994, by Aaberge and Colombino (2006).[10] They are also in the vicinity of what Evers, de Mooij and van Vuuren (2005) report as median estimates for males and females in their meta analysis of labor supply elasticities.

Revenue estimates controlling for labor supply adjustments can be seen in Table 2. Note that the revenue effects from labor supply adjustments are presented as reduced reductions in personal income tax revenue loss, that is, as negative values in Table 2. As expected, employing a labor supply model reduces the estimate of revenue costs of the reform, from approximately NOK8.6 billion to NOK6.4 billion. By comparing the estimates of revenues presented in Table 1 and Table 2, an estimate of the offsetting effects with respect to the personal income tax can be readily obtained. Approximately 25 percent[11] of the initial cost is returned as a result of labor supply adjustments when we use the initial revenue effect with respect to wage earners for comparison. This estimate obviously depends on this actual example, e.g., the composition of this tax reform,[12] employment of the 2006

[10] However, there are some variations for elasticities across different income deciles between our results and these of Aaberge and Colombino (2006). We believe these differences can be explained by different model specifications and data used for estimation. Although these two studies are based on the same general framework, there are considerable differences in the respective model specifications.

[11] The difference between NOK8.578 billion and NOK 6.391 billion, divided by NOK8.578 billion.

[12] In fact, this problem can be alleviated by decomposing into effects of increases in standard deductions, reductions in marginal tax rates, etc., as seen in Finansministeriet (2002, p. 330).

income distribution pattern, validity of the labor supply model, parameter uncertainty of labor supply model, etc. However, it gives an indication of the magnitude of this effect.

Table 2. Estimates of revenue effects of the 2006 reform when labor supply adjustments are included, compared to non-behavioral estimate. In million NOK*

ΔPIR_N (wage earners)	ΔPIR_L	$\Delta CORPR_L$
-8,578	-6,391	818

*1US$=NOK6.418

The labor supply effects affect more than the revenue of the personal income tax. As pre-tax incomes rise, they will affect the revenue of the payroll tax, and since post-tax incomes and consumption are rising, the indirect tax revenue is also affected by changes in labor supply.[13] Let us also briefly present the effects through the payroll tax, before we in the next section describe the contributions from indirect tax revenues.

The Norwegian payroll tax is differentiated with respect to geography into 5 zones. In 2006 14.1 percent of gross labor income was charged in zone 1 (representing 77 percent of the population). It decreases in the other zones according to remoteness from zone 1, ending with a zero tax rate in zone 5. In order to simplify calculations, we employ an estimate for the average payroll tax rate in 2006 of 13.2 percent. An estimate of the additional revenue from corporate taxes because of labor supply adjustments, $\Delta CORPR_L$, is derived by multiplying this rate by the increase in gross income according to labor supply model simulations. The estimated increase in corporate tax revenues is NOK818 million, as seen in Table 2.

5. Revenue effects through increased consumption

In order to obtain revenue effects from indirect tax bases we apply a macroeconomic consumption function:

$$\Delta TCE_j = MPC\ \Delta DISP_j \quad j \in \{N, L\} \tag{1}$$

where ΔTCE_j is the change in total consumption expenditure, dependent on whether we address revenue estimates from a standard LOTTE-Skatt simulation (N) or also take labor supply effects into account through a LOTTE-Arbeid simulation (L). Further, MPC is the marginal propensity to consume, and $\Delta DISP_j$ is the change in disposable income determining the maximum amount available

[13] Another interesting extension is to bring in changes in wage rates and the effect on revenues, so-called third-round effects, as discussed in Creedy and Duncan (2001).

for consumption at the margin. According to the standard tax-benefit model calculation, we have that $\Delta DISP_N = - \Delta PIR_N$ = NOK8,299 mill., see Table 1. Moreover, the additional increase in disposable income due to the labor supply response ($\Delta DISP_L$) is estimated to be NOK4,006 mill.

The marginal propensity to consume (*MPC*) out of disposable income may depend on the current macroeconomic situation, not least of which is consumers' expectations of future income. Were the Ministry of Finance to replicate the tax analysis of the present paper when drafting the budget, we would advise using an *MPC* in line with the budget's wider macroeconomic assumptions.[14] In the present paper we use *MPC* = 0.8.

The change in indirect tax revenues ($INDR_j$) is computed by

(2) $$\Delta INDR_j = MITR\, \Delta TCE_j \quad j \in \{N, L\}$$

where *MITR* is the marginal indirect tax rate when total consumption expenditure is increased by one unit.

Assuming a system of demand functions, or more simply a system of Engel functions, the marginal indirect tax rate of increasing total consumption expenditure by one unit (*MITR*) is given by

(3) $$MITR = \sum_{g \in G} t_g w_g E_g$$

where g stands for commodity group g, G is the set of all commodity groups, t_g is the tax rate for commodity g including value added tax, excise taxes, and adjusted for subsidies, w_g is the budget share for commodity g, and E_g is the Engel elasticity for commodity group g. Note that the tax rates (t_g) and *MITR* are measured in percentage of consumer prices (i.e. post-tax prices). Thus, for a country with a value added tax of 25 percent on all commodities, and no excise taxes or subsidies, we will have t_g and *MITR* equal to 0.25/1.25 = 0.2.

To derive *MITR* for Norway we used the model KONSUM, a micro based macro model with a complete system of demand functions for 60 commodities, see Aasness and Holtsmark (1993) and Nygård and Aasness (2003) on earlier versions.[15] Our results on *MITR* were close to 0.2. In Norway we have a general VAT of 25 percent, implying an *MITR* of 0.2 when we focus on first-round effects of taxation. Lower VAT rates on some commodity groups, in particular food (13 percent), would give lower *MITR*s, while excise taxes on cars, petrol, tobacco, alcohol, electricity, etc. would increase the *MITR*. Summing up all the effects according to (4), it turns out that *MITR* is close to 0.2. We are therefore using this parameter value in the present analysis.

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[14] See Boug et al. (2002) for a description of the main macroeconomic model (MODAG), which is used by the Ministry of Finance.

[15] The Norwegian Ministry of Finance uses a version of this model in their preparation of National Budgets.

Estimated changes in indirect tax revenues ($\Delta INDR_j$) are presented in Table 3. We see that approximately NOK1.3 billion in revenue is obtained from the first round direct effect ($\Delta INDR_N$), as described by standard tax-benefit model simulations, while additionally approximately NOK0.6 billion is attained by also including effects on indirect tax revenues from increased labor supply ($\Delta INDR_L$).

Table 3. Estimates of revenue effects from indirect taxation of the 2006 reform. In million NOK*

ΔPIR_N	$\Delta INDR_N$	$\Delta INDR_L$
-8,299	1,328	640

*1US$=NOK6.418

6. Concluding remarks

The main point of this paper is to question current procedures of providing information about revenue effects of changes in the personal income tax. If one incorporates the effects from labor supply responses, the costs of the 2006 reform is substantially reduced. The paper also demonstrates the benefit of including effects on other tax bases as well. Obviously, lower taxes will affect the revenue from consumption taxes and labor supply responses will affect the revenue from payroll taxes.

Table 4 summarizes the revenue effects addressed in this paper.[16] To calculate an overall rate of self-financing with respect to the reform we have addressed here, we define an estimated overall counteracting effect, *OECE*, by

(4) $$OECE = (\Delta PIR_L - \Delta PIR_N) + \Delta INDR_N + \Delta INDR_L + \Delta CORPR_L .$$

After feeding figures from Table 4 we obtain *OECE* = NOK4,694 mill., which is equal to 56 percent of the initial cost estimate, ΔPIR_N. The degree of self-financing in this case is therefore approximately 56 percent. Of course, this estimate depends on the nature of the income distribution employed, the actual tax reform we are considering, etc. Nevertheless, we are convinced of the usefulness of these estimates because they get closer to the expected costs of tax cuts engendered by changes in the personal income tax.

[16] Note that the estimate of revenue effect of labor supply adjustments differs from the figure given in Section 4, as the base here is the change in revenue for all tax-payers, whereas we restricted to wage earners in Section 4.

Table 4. Summary of revenue effects, in million NOK* and in percent compared to the first round effect

2004-rules applied to 2006: PIR_N	2006 tax-rules					
	ΔPIR_N	$\Delta INDR_N$	ΔPIR_L-ΔPIR_N	$\Delta INDR_L$	$\Delta CORPR_L$	$OECE$
248,345	-8,299	1,328	1,908	640	818	4,694
% of -ΔPIR_N		16 %	23 %	8 %	10 %	56 %

*1US$=NOK6.418

Obviously, the ability of this estimate of self-financing to survive after other effects are included is unresolved. The discussion over the U.S. case concerns effects over a longer time perspective, which raises a number of additional issues including the sort of steps taken to balance budgets.

Related to this, and given that we have a more short-sighted fiscal policy objective in the Norwegian case, some may ask why our calculations do not include expenditure side effects of policy changes. Tax cuts well generally need to be offset by spending cuts and many changes will have substantial effect on the tax revenues. For instance, changing the state sickness benefit will affect labor supply, and changing child care subsidies will affect the labor supply of parents of preschool children. Thus, the estimates one has at one's disposal should be realistic in terms both of budget expenditures and incomes (and their interaction), and employ behavioral simulation models. This is demanding not least because it requires high quality modeling tools. It should nevertheless be one's ambition in this type of work.

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Appendix

The labor supply model in brief

Discrete hours models are popular in tax policy micro simulation, because they obviate the need for marginal calculations, cf. e.g., van Soest (1995) and the review by Creedy and Kalb (2005). Specifically, they enable the researcher to straightforwardly apply quite general specifications of the utility function and incorporate taxation and social security details. They often fail, however, when it comes to replicating the peaks on full-time and part-time hours that typically characterize the distribution of working hours (especially in Europe). Moreover the standard discrete choice approach and the conventional continuous model neglect the demand driven restrictions on the set of job opportunities available to workers. More importantly, however, the overall number of working opportunities varies across individuals: highly educated professionals typically enjoy several job opportunities; the low skilled have fewer to choose from – or none at all.

The labor supply model applied in this paper is based on Dagsvik (1994), Dagsvik and Strøm (2006) and Dagsvik and Jia (2006). In contrast to the approach described above where the household is restricted to have preferences solely over combinations of total consumption and hours of work of the partners, we let the agent have preferences over nonpecuniary job attributes such as the kind of job-specific tasks to be performed, location of the workplace, etc. We have estimated models for married couples, single men and single woman separately. But for simplicity's sake, in the following we restrict our discussion to the single-person household.[17]

Individuals are assumed to choose from a set of jobs denoted by index k. Job k has fixed working hours H_k. The wage rate is assumed to be specific to the individual and is denoted as w. For a given number of hours of work h, $D(h)$ denotes the agent's set of available jobs with hours of work h, i.e. $D(h) = \{z \mid H(z) = h\}$. We denote the number of jobs in $D(h)$ as $m(h)$. For the non-market alternative one can normalize such that $m(0) = 1$.

Let $U\left(C, H_k, Z_k\right)$ be the utility function of the household, where C denotes household consumption (disposable income) and Z_k accommodates the notion that workers may have preferences for job types in addition to income and hours of work.

For given job k, the economic budget constraints is given by

$$C_k = H_k w + I - t(H_k w, I),$$

[17] See Dagsvik and Jia (2006) for a more detailed exposition.

where $t(H_k w, I)$ is the tax function, and I denotes the non-labor income. All the details of the tax/social security rules are taken into account in this function.

We assume that the utility function has the form

$$U\left(C, H_k, Z_k\right) = v\left(C, H_k\right)\varepsilon\left(Z_k\right),$$

where $v(\cdot)$ is a positive deterministic function and $\varepsilon(z)$ is a positive random taste-shifter. Let $\varphi(h \mid w, I, t)$ denote the probability of the agent choosing a particular job with advertized hours h, given the wage rate w, non-labor income is I and the tax rules represented by function t. Under suitable distributional assumptions of the error term $\{\varepsilon(Z_k)\}$, it can be shown that

$$\varphi(h \mid w, I, t) = \frac{v(hw + I - t(hw, I), h)m(h)}{\sum_x v(xw + I - t(xw, I), h)m(x)}.$$

We see that the probability of the agent choosing a job with working hours h has a relatively simple form. It is analogous to a multinomial logit model with representative utility terms $v(hw + I - t(hw, I), h)$ weighted with the frequencies of feasible jobs. Unfortunately, since $m(h)$ is not directly observable, we can often only identify the product $v\left(C, h\right)m(h)$ nonparametrically. Parametric/functional form assumptions on $v\left(C, h\right)$ and $m(h)$ are required for estimation and simulation of the model. In general, the structural part, *v(C,h)*, is specified as a function of observable personal attributes such as age, number of children, etc. We assume that *m(h)* is a uniform density except for peaks at full-time and part-time hours. The full/part-time peak in the hours distribution captures institutional restrictions and technological constraints.

The model is then estimated by the maximum likelihood method on merged data based on the 1997 Norwegian Labor force survey and another two register data sets containing additional information on incomes, family composition, children and education. We consider only households where the male is working. Three models are estimated separately on married couples, single males and single females. The models fit the data rather well.

Wage elasticities

In labor supply models based on the discrete choice framework, the standard labor supply function is not estimated. However, we can still use the concept of the wage elasticity of labor supply to describe the impact of wage rate change on labor supply behavior. In Tables A.1 and A.2 we report what we have called aggregate uncompensated elasticities. They are calculated as follows. For each household we simulate the change in the choice probabilities of working and expected hours of work for the

female and the male resulting from a 10 percent increase in the wage rates. Subsequently, we aggregate over the sample to obtain the corresponding change in mean probability of working and mean expected hours of work. To obtain elasticities, we multiply these figures by 10 and divide by the respective mean probability of working and the mean expected hours of work. Note that since we have excluded the households where the male is not working, for males, we can only calculate the wage elasticities conditional on working. However, the point estimates for the wage elasticities for married and unmarried males, 0.08 and 0.03 respectively, are in the vicinity of median estimates provided by Evers, de Mooij and van Vuuren (2005) for males in their meta analyses.

In general, the tables show that the uncompensated wage elasticities are moderate for married females but small for males and single females. This is consistent with of the several studies surveyed in Blundell and MaCurdy (1999): singles and males in couples tend to have lower labor supply elasticity than secondary earners, i.e. females in couples. For married females the own wage elasticity of the probability of working is equal to 0.33, which means that if the wage rates of married females increase by 5 percent (say) the aggregate fraction of married female who works will increase by 1.5 percent. If the wage rate of the female *and* the male increase, the corresponding elasticity of the probability of working is equal to 0.223. Conditional on working the wage elasticity of mean hours of work is equal to 0.279 for married females. We also note that the elasticities conditional on income groups decrease slightly by income for females but increase slightly for males. However, the elasticities with respect to a change in both wage rates remain practically constant over income groups. The corresponding unconditional elasticities for the females measure the response on total mean hours of work as a result of wage changes. In Table A.1 we note that the unconditional elasticities for married females range from 0.71 in the lowest decile to 0.52 in the highest decile of disposable income. The figure for all married is 0.61, somewhat higher than the mean value for females reported in the meta analysis by Evers, de Mooij and van Vuuren (2005). However, Table A2 shows that unmarried females are much less responsive; an estimate of the (unconditional) wage elasticity of 0.004.

Table A.1. Uncompensated wage elasticities for married couples

		Female base value	Male base Value	Female own wage elasticity	Female cross wage elasticity	Male own wage elasticity	Male cross wage elasticity	Female elasticity with respect to both wage rates	Male elasticity with respect to both wage rates
Probability of working	Whole sample	0.89		0.333	-0.141			0.223	
	Lowest decile	0.87		0.420	-0.181			0.276	
	2nd to 8th decile	0.90		0.332	-0.141			0.223	
	Highest decile	0.92		0.249	-0.090			0.174	
Mean hours of work, conditional on working	Whole sample	1601	2015	0.279	-0.086	0.077	-0.015	0.197	0.063
	Lowest decile	1581	2002	0.289	-0.089	0.067	-0.015	0.205	0.053
	2nd to 8th decile	1602	2015	0.279	-0.087	0.077	-0.015	0.196	0.063
	Highest decile	1618	2030	0.272	-0.083	0.090	-0.014	0.193	0.076
Un-conditional mean hours of work	Whole sample	1444		0.612	-0.228			0.418	

Table A.2. Uncompensated wage elasticities for single individuals

	Male base value	Male wage elasticity	Female base value	Female wage elasticity
Probability of working			0.97	0.023
Mean hours of work conditional on working	1982	0.03	1766	0.002
Unconditional mean hours of work			1720	0.004