De Økonomiske Råd

Heterogeneity in Economic Incentives and Labour Supply Responses - Documentation and Applications of MILASMEC

Jesper Kühl

Working Paper 2010:3

The Secretariat publishes a series of Working Papers, which primarily contains detailed information of selected subjects of the reports by the Chairmanship. The Secretariat is responsible for the series of Working Papers.

Lars Haagen Pedersen
Head of Secretariat

ISSN 0907-2977 (Working Paper – Danish Economic Councils)
List of previous Working Papers: See last page.

To order, contact:

Danish Economic Councils
Secretariat
Amaliegade 44
DK-1256 København K
Denmark

Phone: +45 33 44 58 00
E-mail: dors@dors.dk
Homepage: www.dors.dk

Symbols:
$ Not applicable/data not available.
Due to rounding, the figures in tables may not add up to the totals.

Heterogeneity in Economic Incentives and Labour Supply Responses - Documentation and Applications of MILASMEC

Jesper Kühl

Working Paper 2010:3

Abstract: The model MILASMEC – MIcro data LAbour Supply Model of the Economic Councils – is a micro-simulation model developed by the Secretariat of the Danish Economic Councils in 2008 to analyse the labour market outcomes and distributional consequences of tax reforms. The working paper describes the main characteristics of MILASMEC, documents the considerable heterogeneity in the Danish labour market and illustrates the trade-off for tax reforms between equity and efficiency through a discussion of a number of simulated tax reforms.

Keywords: Labour Supply, Tax, Distribution, Micro-econometric simulation model
JEL: J2, C53.

Contents

1. Introduction

There is an ongoing debate among both decision makers and economists about the appropriate design of the tax system and its effect on labour supply. In Denmark the disincentive effects of high marginal tax rates have been debated for years, culminating in a comprehensive tax reform in the first half of 2009. Furthermore, the distributional effects of tax reform have also received considerable interest. This working paper documents the model MILASMEC – MIcro data LAbour Supply Model of the Economic Councils – developed in the Secretariat of the Danish Economic Councils, and portrays the heterogeneity in the Danish labour market and the variability in the effects of tax reforms.

MILASMEC was developed to shed light on the consequences of various tax reform proposals suggested by the Chairmanship of the Danish Economic Councils during the public discussion of the tax reform. The model was used for the preparation of chapters III and VI in *Danish Economy, Autumn 2008* (The Economic Councils (2008), in Danish only but with an English summary), where the effects of a number of possible tax reforms on overall tax revenues and distribution were examined. To take account of the strong heterogeneity in the population, MILASMEC uses detailed register data. A model of the central taxation of labour income is combined with an income model for people currently out of work. This is combined into a disaggregated model of labour supply effects.

This working paper provides a description of MILASMEC and gives some illustrative applications of the model.[1] In the following two sections the model of the labour supply effects of tax reforms is described. The structure of MILASMEC is outlined in section 4, while section 5 documents the underlying heterogeneity in labour incentives in the population. In section 6 a number of tax reforms are simulated to illustrate the capability of MILASMEC to model labour supply responses and identify the distributional impacts of changes in the tax system. The section is closed with a discussion of the trade-off between equity and efficiency of tax reforms, before section 7 concludes.

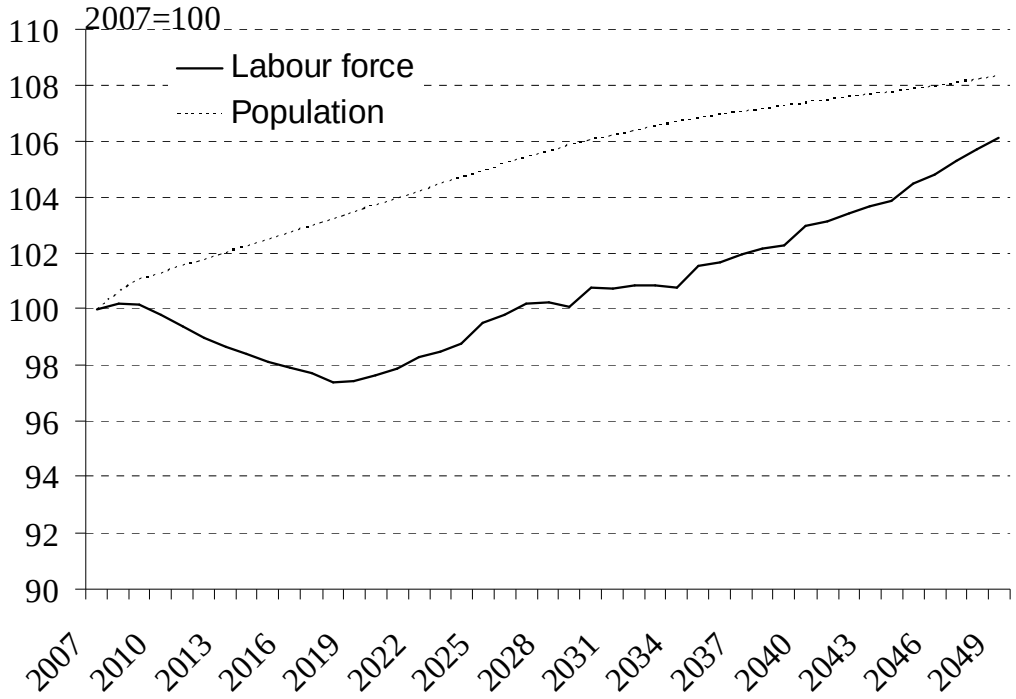
2. Labour supply

The focus on the need to increase labour supply in Denmark stems from two simultaneous developments. The size of the Danish labour force is expected

[1] The results reported in this paper are based on an updated version of MILASMEC, revised and compiled in the first half of 2009.

to fall considerably over the next decade, as large numbers retire, see figure 1. It is not until 2020 that the labour force is projected to start recovering gradually as a result of increases in the retirement age agreed upon in the Welfare Reform in 2006 (*Velfærdsaftalen*). However, the labour force will not attain its 2005 size until approximately 2040. This development will put pressure on the public finances and the publicly provided services, as fewer heads in the labour force will have to provide for a growing number of dependents. An increase in aggregate labour supply is hence necessary to sustain the current welfare arrangements without an increasing tax share.

Figure 1. Long-term projection for the Danish labour force



Note: Based on projections using the CGE-model DREAM, see The Economic Councils (2010).

At the same time as the impending decline in the Danish labour force, the international mobility of the work force has increased substantially, creating or increasing international competition for labour. This calls for a continued examination of the incentive effects of the Danish tax system, as the level of taxation on labour income is one of the incentives for migration.

3. The modelling of labour supply effects

MILASMEC includes three effects of a change in taxation of labour income – the hours response, the participation effect and the broader effect on the taxable income. The effects are differentiated among different subgroups in the population to reflect the considerable heterogeneity in labour supply as well

as incentives for labour market participation and the number of hours worked. After a description of these population groups, sections 3.2 to 3.5 describe the conceptual modelling of the labour supply effects in MILASMEC and its effect on overall tax revenues.

3.1 Labour market groups

Labour markets are characterized by the diversity in the individual characteristics of the workforce, including their actual labour supply and not least the distinction by the state of employment, i.e. whether people are currently in employment or not. To reflect this heterogeneity in the labour market MILASMEC divides all persons aged 16-64 years into a number of labour market groups, including both currently employed and unemployed individuals (table 1). The groups are defined by individuals' labour market states and by the type of transfer payment received, as these implicitly express an individual's attachment to the labour market. All groups are deemed to have a potential labour supply response on the intensive or the extensive margin, as discussed in detail in the following sections.

Table 1. Labour market groups defined in MILASMEC, 16-64 years

	In employment	**Out of employment**
	-- 1,000 persons --	
Full-time employees	2,103	
Part-time employees	199	
Intermittent employees	80	
Unemployed, work-ready		122
Unemployed, not work-ready		71
Leave (from employment)[1]		19
Early retirement pensioners	40	103
Flex-job scheme recipients	31	
Students	205	61
Introduction benefit		3
Disability benefit		232
Non-working, non-recipients		93
Self-employed	154	
Total	2,812	704

[1] Comprises leave with public transfer incomes.
Note: Based on register data for 2006.

The inclusion of the full population of 16 to 64 year olds in the modelling of (potential) labour supply responses diverges from the officially used definition of the Danish labour force, where only the currently employed and un-

employed who are ready to take up work immediately are included. Earlier comprehensive studies of the labour supply effects of tax reforms in Ministry of Finance (2002) and Ministry of Finance (2004) have also taken a more narrow view of potential labour market participants and, for instance, did not include people receiving disability benefits. The broader definition of the workforce defined in MILASMEC reflects that individuals in most life situations may respond to economic incentives for labour supply, even though the degree of response may vary with, for instance, physical abilities, as discussed in the following.

MILASMEC currently does not include persons aged 65 years or older. Increased participation by this age group constitutes a potentially important contribution to a larger labour force, but modelling of the relevant economic incentives for delaying retirement was deemed outside the scope of the model.

Full-time employees work full-time all year round, while part-time employees work all year round, but with lower average weekly working hours, and intermittent employees work full-time, but only for parts of the year.

Among the unemployed a distinction is made between the unemployed who are "ready-for-work" and those that are "not ready-for work", to reflect differing abilities and inclinations to work. The term "ready-for work" (*arbejdsmarkedsparat*) is an administrative term used in the Danish labour market system. The ready-for-work-unemployed include the unemployed with personal unemployment insurance (*dagpenge*) and social assistance recipients without stated work-disabilities (*matchgrupper 1-3*). The unemployed who are not ready-for-work include social assistance recipients with stated impediments to employment (*matchgrupper 4-5*).

The voluntary early retirement scheme (*efterløn*) allows 60- to 65-year olds to retire with comparably generous retirement benefits. They may work when retired, albeit with deductions in their pension payments against labour income.

The flex-job scheme is for employees with permanently reduced work abilities, and the employer receives a wage subsidy from the municipality for each such employee. The introduction benefit is a transfer income, which is lower than ordinary social assistance, and is paid to unemployed foreigners from non-EU and non-Nordic countries with less than 7 years of residency in Denmark.

Disability benefits are permanent transfers given to individuals with permanently reduced work abilities. A change in the economic incentives for work

are not likely to lead to an immediate labour supply response from the employees currently in this group, but may alter the influx to the scheme and, thereby, change labour supply in the medium term.

Non-working, non-recipients are unemployed individuals, who, for the major part of the year, have not received any transfer incomes. Over a third of this group are immigrants from both developing and developed countries and almost half do not have any qualifying degree.[2]

The heterogeneity in the labour market will be brought up again and documented further in section 5.

3.2 Hours response

Every person participating in the labour market chooses his/her hours worked within the scope of, *inter alia*, collective agreements. In this framework, the variation of hours worked with respect to a change in taxation is denoted as the hours response of a tax change. The modelling of the hours response in MILASMEC is based on a standard, one-period static labour supply model, as presented in, for instance, Blundell and MaCurdy (1999), where individuals on the margin choose their hours worked based on their preferences for income and leisure for the current period. In this static framework no account is taken of a possible optimization of hours worked across periods of life, in response to an analyzed change of the tax system.

The tax incentive for the hours response is indicated by an individual's effective marginal wage rate, 1-*m*, where *m* is the effective marginal tax rate.[3] The effective marginal wage rate measures the after-tax income from an extra *kroner* of earnings, and is defined as

(3.1)
$$1-m \;=\; 1-\frac{t_d+t_c}{1+t_c}$$

where t_d is the direct marginal tax rate and t_c is an indirect tax rate, i.e. an excise tax (Sørensen and Skaksen (2007)).[4]

The change in hours worked from a change in the marginal wage rate is approximated by the linear relationship

[2] For an additional 25 per cent no educational information is available, which may stem from immigration.
[3] Indexation by person is suppressed to reduce notation.
[4] A general excise tax of 23.7 per cent is applied (Statistics Denmark (2008), table 2).

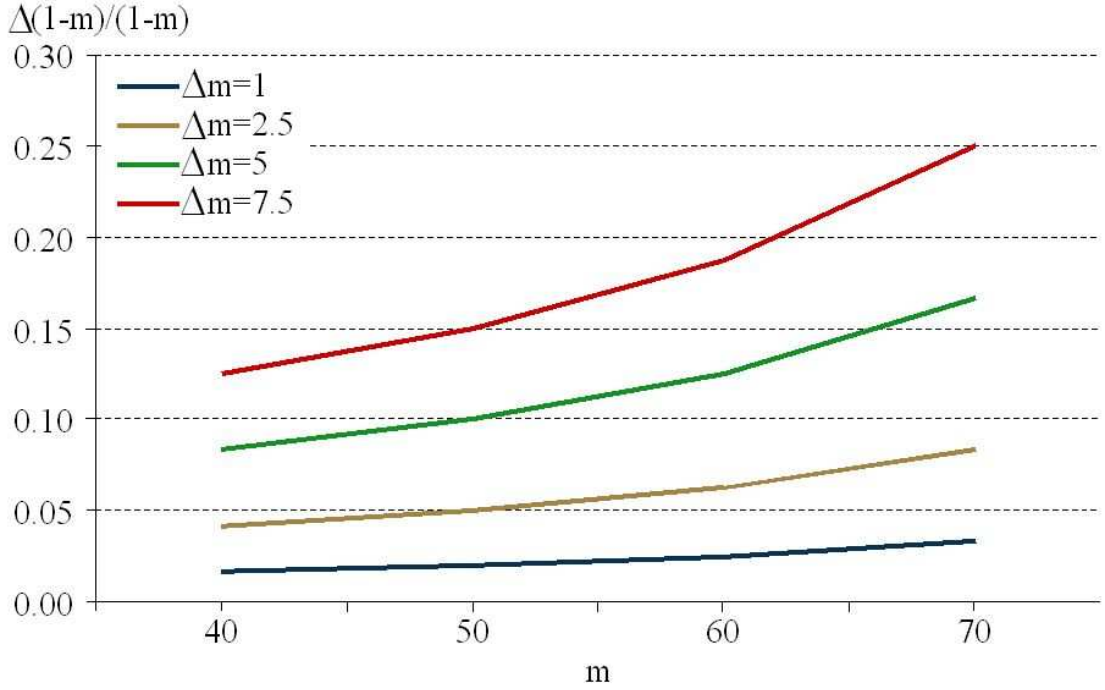
(3.2)

$$\Delta L = L_0 \frac{\Delta(1-m)}{1-m}\varepsilon$$

where L_0 is the initial number of hours worked before a tax change and ε is an exogenous (uncompensated) hours elasticity. A fall in the direct or the indirect taxation will – through a relative increase in the effective marginal wage rate – increase hours worked among those already participating in the labour market.

One characteristic of equation (3.2) is that the term Δ(1-m)/(1-m) is increasing nonlinearly with the initial marginal tax rate m, for a given Δm (figure 2). This can be interpreted as an increasing disincentive effect with increasing tax levels. A given marginal tax change inherently induces a larger hours response for changes in high marginal tax rates than for an equivalent change in a lower marginal tax rate, even though labour supply elasticities are the same. Numerical simulations in The Economic Councils (2008) illustrate this point by showing that the behavioural effect (and thus the revenue recovery rate, discussed in section 3.5 below) falls with increasing tax cuts, as the marginal effect of a tax cut on labour supply decreases.

Figure 2: Larger Δ(1-m)/(1-m) for larger initial m, given Δm



3.2.1. Hours elasticities

The effect of the wage rate on the hours worked is moderated by the hours elasticity ε. The responsiveness to economic incentives may, however, vary among the employed and ε is differentiated among individuals participating in the labour market (table 2).

Table 2. Elasticities at the intensive margin for different labour market groups

Full-time employees	0.10
Part-time employees	0.10
Intermittent employees	0.12
Early retirement pensioners	0.03
Students	0.05
Flex-job scheme recipients	0.01
Self-employed	0.15

Notes: All elasticities are exogenously set, partly based on the results in Frederiksen *et al.* (2008). For definitions of the labour market groups see table 1 and accompanying text. All elasticities are uncompensated elasticities. No hours response is modelled for the self-employed, as no data on their labour supply is available. However, they do exhibit a general response on the intensive margin, noticeable from the effect on the taxable income.

The assumptions about the elasticities of hours worked for full-time employees are based on a study by Frederiksen *et al.* (2008).[5] For some of the other groups the elasticities are adjusted to take account of their labour market abilities, as discussed below. Though based on data from 1996, the study is the most recent estimation of labour supply elasticities in Denmark. The study uses a survey of actual hours worked, combined with a structural model of individual preferences for income and leisure. The elasticities presented in table 2 are uncompensated elasticities and are assumed to be independent of initial hours worked, initial income and gender.

For full-time and part-time employees, an hours elasticity of 0.1 is assumed. Part-time employees may have more room to increase their hours of work, but their part-time status may also indicate a higher marginal utility of leisure. With these conflicting arguments, they are given the same magnitude of response as the full-time employed.

For intermittent employees an hours elasticity of 0.12 is applied. They are assumed to have a comparably larger margin of response than full- and part-

[5] Frederiksen *et al.* (2008) estimate separate elasticities for men and women. This distinction is not included in the current version of MILASMEC.

time employees, as they may not only alter their number of hours worked weekly, but also the number of weeks or months, in which they are working.

The hours elasticity for early retirees in work is set to 0.03, which is considerably lower than for the full-time employed, as their choice of the early retirement scheme reflects either a higher marginal utility of leisure or physical disabilities.

The majority of students work while studying and a change in the taxation of their labour income may induce them to change their hours worked. Their hours elasticity is set to 0.05, which is lower than the comparable group of part-time employees. This reflects the lost time for studies incurred by additional hours worked and deductions from their study allowance against labour income.

Flex-job scheme recipients have stated disabilities, making them eligible for the scheme. Their ability to react to altered economic incentives for work may therefore be small. They may however receive pay supplements for good performance and are therefore assumed to have a positive, albeit small, hours elasticity of 0.01.

Other prominent Danish examinations of the labour supply response to changes in the tax system (most notably, Ministry of Finance (2004) and Skatteministeriet (2008)) also take the estimations in Frederiksen *et al.* (2008)[6] as their starting point, but they apply the elasticities slightly differently. The elasticities used in Ministry of Finance (2002) are individual-specific elasticities calculated as functions of gender, hours of work, marginal wage rate and income, based on the modelling framework of Frederiksen *et al.* (2001). This yields an average uncompensated substitution elasticity of 0.1 (Ministry of Finance (2002), table 7.4), which is of a comparable magnitude to the elasticities used in MILASMEC.[7]

A more recent modelling of the labour supply response of tax changes found in Skatteministeriet (2008) weights the gender-specific elasticities in Frederiksen *et al.* (2001) for a number of income intervals (Skatteministeriet (2008), table 3.2).[8] For the full population they calculate an average compensated elasticity of 0.10 and an income elasticity of 0.005.

[6] The studies refer to Frederiksen *et al.* (2001), the predecessor of Frederiksen *et al.* (2008), presenting the same estimation results.

[7] The simulations in Ministry of Finance (2002) did not include flex-job scheme recipients.

[8] Skatteministeriet (2008) employs a simulation model similar to equation (3.2), but assumes that all individuals initially work 1,600 hours before a tax change.

3.3 Participation effect

The state of the labour market as well as an individual's qualifications and job search intensity contribute to whether a person is employed or unemployed. An exogenous change in the economic consequences of being employed or unemployed, for instance, a fall in labour income taxation, can affect the job search intensity and, thereby, the propensity to find employment. This effect on employment from a change in taxation is denoted as the participation effect.

The decision to seek – or retain – employment is influenced by the after-tax economic gain from being employed and receiving an income I_L rather than being unemployed with an income I_U. This income gap G – the economic gain from employment – is formalized as the difference in after-tax income between working and not working, normalized by the indirect tax rate,

$$\mathbf{(3.3)} \qquad G = \frac{(1-t_d^{'})I_L - (1-t_d)I_U}{(1+t_c)}$$

where labour income and transfer incomes may be taxed at differential rates $t_d^{'}$ and t_d, respectively, as it is mostly the case in progressive tax systems.

Following The Economic Council (2004), the overall participation effect in MILASMEC is modelled as the relative change in the number of unemployed, U, in a labour market group, j, with respect to the relative change in the economic gain from employment,

$$\mathbf{(3.4)} \qquad \Delta U_j = -U_j^0 \frac{\Delta G_j}{G_j^0} \cdot \eta_j \quad ,$$

where η_j is the participation elasticity – the effect of the economic gain from employment on the number of unemployed – for labour market group j, and U^0 is the initial number of unemployed in that group. An increase in the economic gain from employment will improve the incentives to enter work and, by equation (3.4), reduce the number of unemployed.

3.3.1. Participation elasticities

Equation (3.4) is applied separately to nine groups of unemployed in the Danish labour market for whom the size of the participation elasticity is differentiated, see table 3. Employees on leave, early retirees and non-working, non-recipients are all given the same elasticity as the unemployed deemed ready-for-work, since they do not have any registered work disabilities and therefore

can respond to a change in the economic gain from employment. For the early retirement scheme and employees on leave the implied participation effect is made up of a lower future entry to the transfer schemes and a lower duration of out-of-work.[9] The remaining groups are assigned lower participation elasticities, reflecting disabilities or (particularly for students) preferences for alternative time uses.

Table 3. Participation elasticity for different labour market groups

Unemployed, work-ready	0.10
Unemployed, not work-ready	0.05
On leave (from employment)	0.10
Early retirement scheme	0.10
Introduction benefit	0.05
Disability benefit	0.01
Students	0.05
Non-working, non-recipients	0.10

The participation elasticities broadly correspond to the elasticities used in the Danish dynamic computable general equilibrium model DREAM (DREAM (2008)). A recent Danish study of the labour market participation of recipients of social assistance found participation elasticities of 0.09-0.17 for men and 0.13-0.20 for women (le Maire and Scheuer (2008)). The authors argue that unobserved heterogeneity lends these estimates an upward bias, rendering their estimates closer to the assumptions made for MILASMEC.

Some parts of the literature have defined the participation response with respect to the number of employed, L, or the total work effort (e.g. Kleven and Kreiner (2006b); Saez (2002)). The participation elasticity η in equation (3.4) can be rewritten as an elasticity with respect to employment L, η_L, as $\eta_L = \eta(1-d)/d$, where d is the participation rate.[10] That is, with a participation rate of, say, 80 per cent, a participation elasticity η of 0.1 with respect to unemployment corresponds to an elasticity with respect to employment, η_L, of 0.025.

The specified participation elasticities are uncompensated substitution elasticities between the economic gain from employment and the number of unemployed. If agents are liquidity constrained, a change in benefits may also have a separate (income) effect on search behaviour and employment take-up (Chetty (2008)). The current version of MILASMEC does not specify a dis-

[9] The modelling of the incentive structure for early retirees does not take account of the fact that a postponement of (early) retirement also entails higher pensions in the future, as the contribution period to personal retirement schemes is extended.

[10] This result follows from equation (3.4) and recognizing that from $U = W(1-d)$ and $L = Wd$ it holds that $U = L\,(1-d)/d$.

tinct income effect from social benefits as this effect was deemed less relevant for the case of tax cuts studied for the analysis in The Economic Councils (2008).

Other studies have specified their participation effect as the effect of the replacement rate, *K*, on the unemployment rate, *u*, where *K* is after-tax income in unemployment as a percentage of the after-tax income in employment,

(3.5) $$\Delta u = \alpha \cdot \Delta K \quad .$$

It can be shown (see Appendix A), that this specification can be rewritten in terms of unemployment, *U*, and the economic gain from employment *G*, comparable to equation (3.4), as

(3.6) $$\Delta U_j = -U_j^0 \frac{\Delta G_j}{G_j^0} \cdot \alpha \cdot (1-K) \cdot \frac{1}{u} \quad ,$$

This enables a comparison of the participation elasticities in the two different specifications. Taking, for instance, the simulations presented in Ministry of Finance (2002), where $\alpha = 0.07$, and assuming *u* to be 3.5 per cent and an average *K* of 50 per cent, yields $\eta_a = \alpha \cdot (1-K) \cdot 1/u = 1$, which is considerably larger than the MILASMEC-assumptions in table 3.

3.4 Effect on taxable income

A change in the taxation of labour income may have other, more subtle effects than the hours response and the participation effect. A reduction in the marginal tax rate may induce individuals to increase their effort on the job, engage in education or training, seek a better-paying job or reduce the share of (untaxed) fringe benefits in favour of a higher taxed income.

The impact of taxation on both number of hours worked and on these additional dimensions of labour supply is reflected in a change in taxable income, *S*, with respect to a change in the after tax wage rate,

(3.7) $$\Delta S = S_0 \frac{\Delta(1-m)}{1-m} \gamma$$

where γ is the elasticity of taxable income and 1-m is defined in equation (3.1). An increase in the after-tax wage rate can induce workers to either increase their number of hours worked or increase their labour productivity by,

for instance, on-the-job training. Both types of response will increase their pre-tax wage income, *S*.

In MILASMEC the elasticity of taxable income is set to the same level as the hours elasticity, cf. table 2. A range of empirical studies of the elasticity of taxable income show that the additional dimensions of labour supply among the already employed imply a higher elasticity on the intensive margin, cf. the Nordic studies by Holmlund and Söderström (2007), Hansson (2004) and Ljunge and Ragan (2005) or the survey by Meghir and Phillips (2008). However, MILASMEC applies the lower – relative to the international literature – elasticities shown in table 2, which is also in line with recent empirical results for Denmark in Kleven and Schultz (2009). Their study employs detailed register data and examines a series of Danish tax reforms in the period 1987-2004 and finds modest population-wide labour income elasticities of 0.08 to 0.10, with higher elasticities for the self-employed.

3.5 Revenue recovery rate

From a public policy point of view it is not only the direct labour supply effects that are of interest, but also the consequences for tax revenues. This revenue effect from a change in the tax system can be decomposed into two parts. Keeping individual labour supply and gross incomes constant, a tax cut leads to a first-order fall in overall tax receipts. This effect is termed the mechanical revenue effect of a tax change (Kleven and Kreiner (2006a)). Responses in labour supply through labour market participation, the hours worked, productivity, etc. lead to changes in the individual tax bases and tax payments. This second-order effect from behavioural responses to changes in the tax system is typically termed the dynamic revenue effect of a tax change.

The net impact of a change in the tax system on tax revenues can be summarized by the revenue recovery rate – the dynamic revenue effect as a percentage of the mechanic revenue effect. The revenue recovery rate summarizes what percentage of the initial revenue loss from a tax cut is recovered through the positive behavioural effects, as they were modelled in sections 3.2 to 3.4. If a tax cut with a 1st-order revenue effect of, say, 1 billion *kroner* leads to a 2nd-order revenue increase from the behavioural labour supply response of 0.5 billion *kroner*, the tax cut has a revenue recovery rate of 50 per cent. Likewise, for a tax hike, the recovery rate expresses the share of the initial additional tax revenue that is lost from negative behavioural effects.

With T_0 denoting the overall tax revenue before any changes in the tax system, T_1 the tax revenue with the mechanical revenue effects from a tax change

included and T_2 the overall tax revenue with both the mechanical and the dynamic revenue effects included, the revenue recovery rate can be written as

(3.8)
$$r = \frac{T_2 - T_1}{T_0 - T_1} \quad .$$

MILASMEC incorporates the contribution of indirect taxes, such as excise and sales taxes, on the economic incentives for labour supply, see equations (3.1) and (3.3). The current version of the model does not take into account the (3rd-order) revenue effects from these indirect taxes. A tax cut may, through the increase in after tax income, increase consumption and hence revenues from indirect taxes. These 3rd-order effects of a tax change will increase the revenue recovery rate for a tax cut and reduce it for a tax hike, *ceteris paribus*.

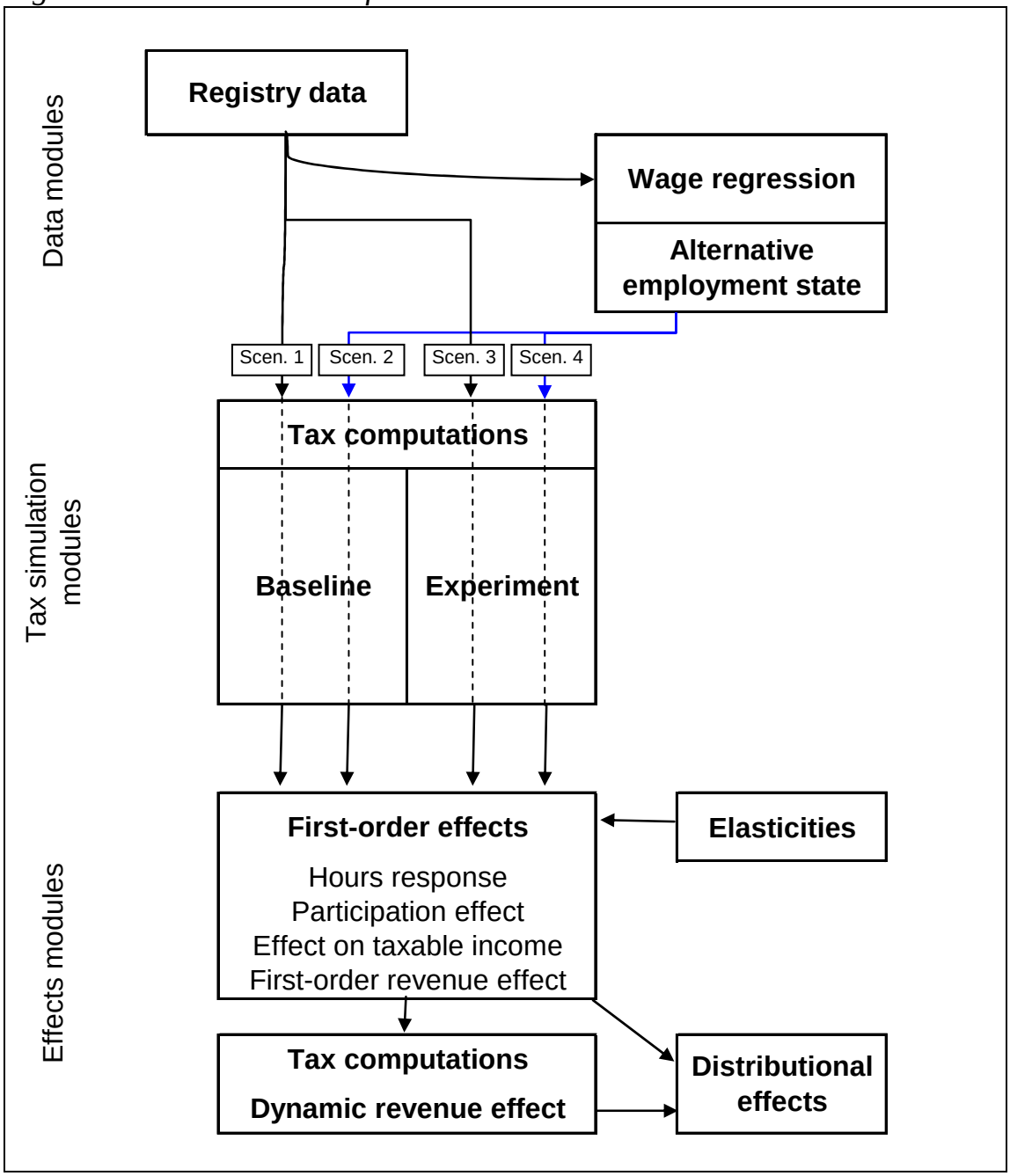
4. Technical structure of MILASMEC

MILASMEC models labour supply effects, as described above, using Danish register data for all persons aged 16-64 years, i.e. approximately 3.5 million individuals. In the following the basic structure of MILASMEC is described, while section 5 presents an application of the model.

The technical structure of MILASMEC is illustrated in figure 3. The presentation is simplified considerably, but shows the main computational elements.[11] The model can, for conceptual reasons, be divided into three groups of modules, the data modules, the tax simulation modules and the effect modules.

[11] More detailed documentation of MILASMEC (in Danish only) is available upon request from the Secretariat of the Danish Economic Councils.

Figure 3. The structure of MILASMEC



4.1 Contra-factual comparison of scenarios

The calculation of the labour supply effects of a tax reform requires the contra-factual comparison of both the marginal wage rate and the economic gain from employment, with and without the hypothetical reform, following equations (3.2), (3.4) and (3.7). The necessary computations for the tax calculations can be summarized as

Scenario 1: Observed employment state, without tax reform

Scenario 2: Alternative employment state, without tax reform

Scenario 3: Observed employment state, with tax reform

Scenario 4: Alternative employment state, with tax reform

That is, MILASMEC derives a baseline for the computations from a specification of the current tax regime (scenario 1). In this baseline individual's actual tax payments are recalculated and the model computations can be checked. In the same tax setting the economic consequences of the alternative employment state – unemployment for the currently employed and vice versa – is computed (scenario 2). From a specification of the tax rules where a potential tax reform is implemented – for instance a rate reduction – tax scenarios can be derived in the same way (scenarios 3 and 4). This allows the computation of the change in the marginal tax rate and of the change in the economic gain to employment.

4.2 Data modules

In the first group of modules, the register data are assembled and the (hypothetical) alternative employment states – simulating unemployment for persons currently in work and employment for persons currently out of work – are calculated. These alternative employment states are needed to compute the income gap.

4.2.1. Benefit transfers in unemployment

For individuals currently employed the economic situation in unemployment is simulated through the assignment of transfer incomes according to the rules for unemployment benefits (*dagpenge*) and social assistance (*kontanthjælp*), taking account of differences in benefit levels by age and family status.

4.2.2. Labour income for the currently unemployed

To predict the labour income for individuals currently out of work a wage model explaining the hourly wage as a function of a number of covariates is estimated. The model controls for the endogenous selection into employment, as the observation of employment and wage income may be a function of the market wage offered and individuals' reservation wage. To this end the wage model applies a standard two-stage Heckman-approach, where participation in the labour market is modelled in a first stage, yielding a correction factor for the second stage wage regression (Heckman (1976)).

Explanatory variables for both the first and the second stages include gender, age, employment sector, education, immigration status, geographical indicators and indicators for the labour market groups specified in table 1.[12] The endogeneity of labour market participation can be resolved through the use of information that only affects labour market participation but not the potential wage level. For this, three identifying variables that reduce the probability of employment are used; the number of children, marital status and eligibility for unemployment benefits. While the number of children reduces the probability of employment directly, both marriage and the eligibility for unemployment benefits do so through a reduction in the costs of unemployment.

The wage regression is used to predict hourly wages for individuals currently out of work, and to calculate their yearly labour income, using an imputed number of yearly working hours of 1,544 hours.[13]

4.3 Tax modules

In the second group of modules, the tax calculations are undertaken. MILASMEC mirrors the most common and generally applied personal tax rules in Denmark and captures the taxes faced by the majority of tax payers.

The register data used contains information on personal characteristics, labour income, transfer incomes, capital income and other incomes types as well as typical deductions for, for instance, pension scheme payments or transport allowances. This allows the model to compute the tax bases for the Danish tax system, namely the personal income base (*personlig indkomst*) and the taxable income base (*skattepligtig indkomst*), which are taxed at different rates at the national and regional (county, municipality) levels. The calculation of individual tax obligations in MILASMEC then mirrors the tax system that contains a gross flat tax levied on all labour income, municipal and county taxes levied on the taxable income-base and three progressive tax rates at the national level. The calculations also take account of the possibilities for married couples to transfer redundant deductions in the different tax bases.

4.4 Effects modules

In the effects modules the results from the four tax scenarios can be translated into labour supply effects and the mechanical and dynamic effects on tax revenues can be computed, cf. sections 3.2-3.5.

[12] Regression results are available upon request.

[13] This corresponds to the average number of yearly working hours for wage-earners in Denmark in 2007 (Statistics Denmark (2007)).

Scenarios 1 and 3 yield the marginal tax rate with and without the hypothetical tax reform. Denoting scenarios by superscripts, the relative change in the marginal wage rate can, for each individual *i*, be computed as

(4.1)
$$\frac{\Delta(1-m_i)}{1-m_i} = \frac{\left(1-m_i^3\right)-\left((1-m_i^1)\right)}{(1-m_i^1)} \quad .$$

The economic gain from employment can be calculated by calculating the difference in after tax incomes between working and not-working, with and without the tax reform (difference between scenarios 1 and 2 and difference in scenarios 3 and 4, respectively). The relative change of the economic gain from employment for labour market group *j* can then be found as

(4.2)
$$\frac{\Delta G_j}{G_j} = \frac{1}{N_j}\sum_i \frac{\left(I_{ij}^3 - I_{ij}^4\right)-\left(I_{ij}^1 - I_{ij}^2\right)}{\left(I_{ij}^1 - I_{ij}^2\right)}$$

where I_{ij}^S is the after tax income in scenario *S* for individual *i* in labour market group *j*. N_j is the number of individuals in labour market group *j*.

Equations (4.1) and (4.2) yield the incentive parameters for the labour supply responses on the intensive and the extensive margins, respectively. This allows the calculation of the first-order mechanical effects of the hypothetical tax reform on the extensive and intensive margins of labour supply, using equations (3.2), (3.4) and (3.7).

These 1st-order mechanical effects give rise to changes in the tax bases, as discussed in section 3.5. To capture this effect, MILASMEC calculates revised tax bases, and loops back to the tax modules to calculate revised individual tax obligations, given the 1st-order effects. This allows the revenue recovery rate to be calculated.

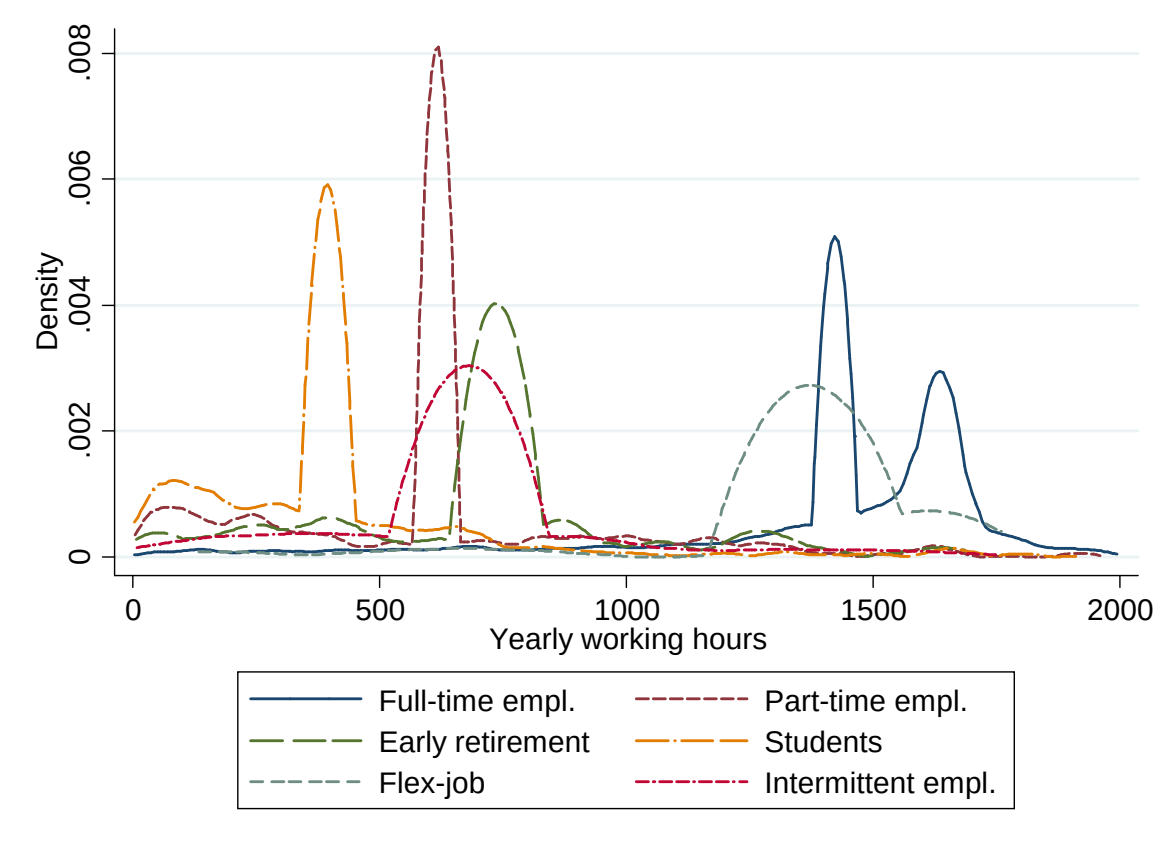
5. Heterogeneity in labour incentives

There is strong heterogeneity in the labour force with respect to, for instance, education, experience, abilities, potential hourly wage and preferences for work in the population. This will obviously translate into a strong heterogeneity in the observed labour supply and in the receptiveness to economic incentives for work and employment. MILASMEC has partly been developed to account for this heterogeneity and the following sections demonstrate the ability of the model to reflect the large heterogeneity in both the incentives for work and employment and the corresponding differences in the responsiveness to changes in the taxation of labour income.

5.1 Variations in labour supply

Individual yearly working hours in the labour force vary considerably, as shown in figure 4. Full-time employees work around 1,500 hours a years, while the majority of part-time and intermittent employees record 600-700 hours of work a year. The majority of students with part-time employment work 400-500 hours a year, but their distribution of hours shows a heavy left tail.

Figure 4. Yearly working hours for different labour market groups



Note: The graph is based on a 7 per cent sample of all employed persons in 2006. The hours distributions are smoothed using a moving epanechnikov-kernel.

5.2 Economic gain from employment

The economic gain from employment is a function of, on the one hand, transfer income in unemployment and, on the other hand, wage income from employment (equation (3.3)). Higher (potential) transfer incomes reduce the economic gain from employment, while a higher (potential) disposable wage income increases it.

The economic incentive to seek or retain employment varies greatly among individuals of working age (table 4). Unemployed individuals who do not receive any transfer income (non-working, non-recipients), for instance, have a mean economic gain from employment of over 130,000 DKK, while the corresponding gain from employment for unemployed individuals receiving unemployment benefits, on average, is only approximately 40,000 DKK per year.

Closer analysis also reveals considerable heterogeneity in the economic gains to employment within the defined labour market groups. Students, on the one hand, show the lowest heterogeneity, expressed by the interquantile range between the 25%- and the 75%-quantiles relative to the mean level of the economic gain to employment, as they have similar current incomes from student grants and part-time employment and similar employment outlooks, given their education and experience. The three different groups of unemployed, on the other hand, show the highest heterogeneity, as transfer incomes within these groups are dependent on age and family status. Moreover, the groups each cover potential employees across a wide range of educational attainments and experience and consequently wage incomes.

Table 4: Gains from employment for different labour market groups

	Economic gain from employment		
	25%-quant.	**Mean**	**75%-quant.**
	---------- DKK ----------		
On leave	53,558	71,754	88,352
Early retirement scheme	69,354	78,800	88,131
Unemployed, insured	26,622	39,831	54,997
Unemployed, match group 1-3	44,110	62,884	81,503
Unemployed, match group 4-5	40,318	53,532	67,229
Introduction benefit	59,067	75,643	101,061
Disability benefit	55,122	68,070	82,983
Students	82,178	92,222	100,327
Non-working, non-recipients	103,013	133,907	162,017
Total	52,937	75,478	91,864

Note: Based on register data for 2006, in 2009-prices. See sections 3.2 and 3.3 for a closer description of the labour market groups. The gains from employment are calculated for full-time employment.

5.3 Marginal tax rates

The incentive for a person in employment to work an additional hour is captured by the after tax income from an additional *kroner* earned; the marginal effective wage rate 1-*m*, as defined in equation (3.1).

In a progressive tax system such as the Danish one, gross yearly (labour) income is taxed in a number of tax brackets with increasing marginal tax rates. The effective marginal tax rate thus depends on both the number of hours worked and the hourly wage. Full-time employees show the highest number of working hours and, on average, face the highest marginal tax rate of almost 50 per cent, cf. table 5 and figure 4. Part-time employees with lower working hours and a lower hourly wage have a marginal tax rate of only 31 per cent, on average.

Table 5. Direct and effective marginal tax rates

	Direct marginal tax rate	**Effective marginal tax rate**
	--- per cent ---	--- per cent ---
Full-time employees	49.5	59.1
Part-time employees	31.2	44.4
Intermittent employees	35.0	47.4
Early retirement scheme	43.8	54.6
Students	32.1	45.1
Flex-job scheme recipients	42.3	53.4
Self-employed	42.8	53.8

Note: See sections 3.2 for a closer description of the labour market groups. Among students and recipients of early retirement benefits the table only includes individuals in employment.

However, the real wage rate has to include not only the direct taxation of labour income, but also the subsequent indirect taxation levied on the consumption of goods and services. Consumption taxes reduce the real value or purchasing power of the net wage rate. An increase in the indirect taxation of goods and services is thus conceptually equivalent to an increase in the direct taxation of labour income and enters the effective marginal tax rate (equation (3.1)). Calculations show that indirect taxation increases the net taxation of labour income significantly (rightmost column of table 5). Full-time employees, on average, face an effective marginal tax rate of 59 per cent. Even the lowest direct marginal tax rate – for part-time employees – climbs from 31 to 44 per cent, when consumption taxes are accounted for.

6. Heterogeneous effects from tax experiments

To further illustrate the heterogeneous effects of tax reform in the Danish population, a range of tax reforms are simulated.[14] Firstly, the labour supply and distributional outcomes of a reduction in a broad gross marginal tax rate are discussed in detail. Hereafter, two simulations – a reduction in the top marginal tax rate and the abolition of the two highest progressive tax brackets – are examined, before a number of other possible tax reforms are reviewed. These simulations illustrate the heterogeneous nature of tax reforms in terms of both labour market outcomes and distributional consequences, and the section concludes with a discussion of the trade-off between equity and efficiency in the design of tax reforms.

6.1 A simulated reduction of a gross tax rate

The labour market contribution (*arbejdsmarkedsbidrag*) is a gross tax levied upon all labour income, i.e. before any deductions can be made. Hence, it is paid by all workers in the Danish labour force, in contrast to the progressive taxes, which only affect certain income bands. This universality makes the labour market contribution well suited for the examination of heterogeneous labour supply effects.

The labour market contribution currently stands at 8 per cent of gross labour income. In the following, a reduction in the labour market contribution by 0.25 percentage points is simulated, corresponding to a net reduction in tax receipts by approximately 1 billion DKK.[15]

6.1.1. Hours response

The reduction in the labour market contribution increases the after-tax wage rate for the approximately 2.7 million employed persons in the labour force by, on average, 0.17 per cent (table 6). The labour market contribution makes up a larger part of the tax payments for low income groups, compared to higher income groups, who pay an increasing share of their taxes as progressive taxes. A reduction in the labour market contribution consequently in-

[14] The simulations presented do not take account of the changes in the Danish tax system that took effect in 2010. So the baseline for all tax reforms is the tax system in 2009.

[15] This tax experiment does not reflect the true, real-world effects of a reduction in the labour market contribution, as the level of public transfers are kept constant here. The Danish legal system implies that transfer incomes are increased when the labour market contribution is reduced, which nullifies any positive incentive effects at the extensive margin from the tax reduction.

creases the wage rate relatively more for lower-income groups, for instance part-time employees, than for full-time employees.

The increase in the effective wage rate gives rise to a total increase in yearly working hours corresponding to 325 full-time employed persons. This effect is predominantly driven by the full-time employees who have the lowest average increase in their wage rate, but also have the highest initial number of yearly hours worked and are by far the largest of the defined labour market groups.

Table 6. Hours response from reduction in labour market contribution

	Average change in wage rate	**labour supply**	**Aggregate labour supply effect**
	-- per cent --	-- hours --	-- persons --
Full-time employees	0.16	0.21	292
Part-time employees	0.24	0.15	19
Other employees	0.20	0.05	14
Total	0.17	0.18	325

Note: The after-tax wage rate is defined as 1-*m*, where *m* is the effective marginal tax rate. The aggregate labour supply effect assumes an average yearly hour supply of 1,544 hours (Statistics Denmark (2007)).

6.1.2. Participation effect

The labour market contribution is only levied on wage income and not on transfer incomes. A reduction in the contribution rate thus increases the economic gain from employment for the approximately 700.000 people out of work, as it increases the after-tax share from wage income relative to the after-tax share from transfer income.

All persons out of work, on average, face an increase in their economic gain from employment of 0.49 per cent (table 7). For the hours response, the lowest income groups had the largest relative gains in the after-tax wage rate. For the participation response, the unemployed with the highest (potential) incomes experience the largest gains from the tax cut, since the labour market contribution is a linear tax. The tax obligation – and correspondingly the reduction from a tax decrease – thus increases with increasing incomes. The unemployed, who are categorized as ready-for-work, on average, have the highest potential labour income among the groups analyzed and, therefore, experience the biggest economic gain from employment. Persons, who are out of work and have not received any transfer incomes over the main part of the

year, on the other hand, have the lowest potential wage income and, consequently, the lowest increase from this tax cut.

A total of 205 individuals would be expected to enter employment in response to a reduction in the labour market contribution such as that analysed here. Almost two-thirds of these extra workers come from the groups of early retirees and the ready-for-work unemployed, reflecting both their comparably high increases in economic gains from employment and the comparably large sizes of these groups.

Table 7. Participation effect from reduction in labour market contribution

	Average change in econ. gain from employment	**Aggregate labour supply effect**
	-- per cent --	-- persons --
Early retirement scheme	0.53	54
Unemployed, ready-for-work	0.62	76
Students	0.29	9
Non-work, non-recipients	0.26	25
Others out of work	0.54	42
Total	0.49	205

6.1.3. Revenue effects

The reduction in the labour market contribution leads to an immediate fall in tax receipts of approximately 1.1 billion *kroner*. However, the tax cut gives rise to a total increase in the labour force of (the equivalent to) over 500 full-time workers. This leads to an increase in tax receipts from the additional labour income and a decrease in public expenditures from saved transfer incomes. Hence, 112 million *kroner* of the first-order fall in tax revenues can be recouped, which is equivalent to a revenue recovery rate of 10 per cent. This is, however, a lower bound on the recovery rate, as increases in indirect tax revenues are not accounted for, see the discussion in section 3.5.

6.1.4. Distributional impacts

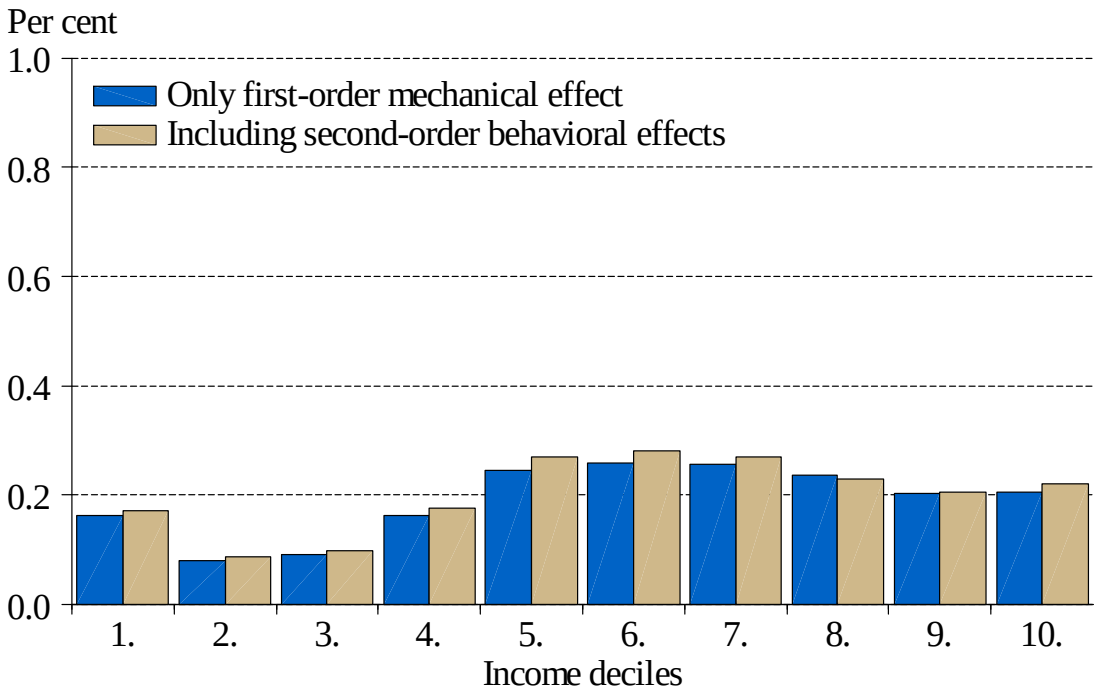
Distributional concerns are high on the political agenda in Denmark and the evaluation of the distributional impacts of tax reform proposals is, therefore, highly policy-relevant. Once the first- and second-order effects of a tax reform are simulated, MILASMEC can compute the percentage changes in the disposable incomes for every person. The distributional effects for the simu-

lated reduction in the labour market contribution rate are here shown as the effects on after tax incomes across deciles.

All deciles experience an increase in the average disposable income of 0.1-0.25 per cent from the first-order mechanical effects of the tax cut (figure 5). Most tax payers would see an increase in their marginal wage rate after the tax cut and, consequently, would increase their labour supply. This shows up as a further increase in disposable income from the 2nd-order effects for almost all deciles.

The peculiar fall in average disposable income for the 8th decile from the second-order effects is attributable to the fact that some individuals move into a higher tax band as a result of the first-order increase in income from the tax cut. Hence, their effective marginal tax rate increases and they consequently reduce their labour supply, reducing their disposable income.

Figure 5. Distributional effects of a reduction of a gross tax rate



Note: Income deciles are calculated for after tax incomes.

6.2 A reduction of the top marginal tax rate

The reduction in the gross tax rate analysed above benefited all, but only achieved a small revenue recovery rate. The opposite case can be observed for a reduction in the top marginal tax rate (*topskat*), which affects approximately 1 million tax payers.

Again, normalizing the tax cut to a mechanical revenue loss of 1 billion *kroner*, a reduction in the top marginal tax rate of 1 percentage point is analysed.[16] This analysis was reported previously in The Economic Councils (2008).

The cut in the top marginal tax rate elicits an increase in labour supply on the intensive margin by, on average, 1 hour per year, corresponding to 1,865 full-time employed persons. Only a minority of the currently unemployed have potential wage incomes in the top marginal tax bracket, and the tax cut therefore only gives rise to a participation response of less then 10 employees.

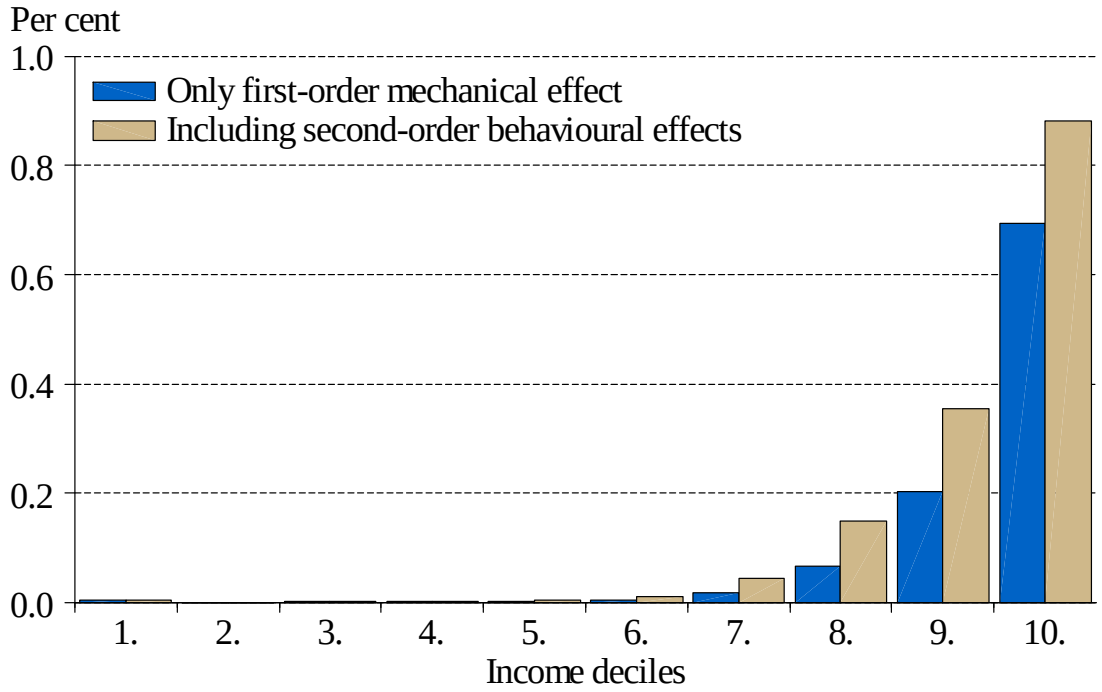
The large behavioural effects at the intensive margin of the cut in the top marginal tax rate lead to a dynamic revenue gain of 650 million *kroner*, yielding a revenue recovery rate of 57 per cent. This result is in line with earlier simulations for Denmark, notably Skatteministeriet (2008), Ministry of Finance (2002) and The Economic Council (2004). Other Nordic studies find revenue recovery rates of over 100 per cent for reductions in top marginal tax rates (Kleven and Kreiner (2006a), Holmlund and Söderström (2007)). These studies, however, assume higher labour supply elasticities and do not consider the mechanical revenue loss arising from pensioners' tax payments.

A reduction in the top marginal tax bracket only affects high-income earners and hence only benefits the upper half of the income distribution (figure 6). While individuals up to the sixth decile only experience marginal gains in their after-tax income,[17] individuals in the top income decile can record an increase of 0.9 per cent, including the behavioural effects.

[16] Beyond the mechanical revenue loss from persons aged 16-64 years, an additional revenue loss of 120 million *kroner* is incurred from pensioners in the top marginal tax bracket.

[17] The slight gains recorded for income deciles in the lower half of the distribution are attributable to negative capital incomes, which place high-income earners – who gain from the flat tax reform on their labour income – into the lower quintiles for their disposable income.

Figure 6: Distributional effects for a reduction of the top marginal tax rate



Note: Income deciles are calculated for after tax incomes.

6.3 A flat tax-experiment

The abolition of progressive taxation in favour of a single marginal tax rate applied to all income levels is a limit case in the reduction of the disincentive effects of marginal taxes (see e.g. the survey in Keen *et al.* (2008)). In the following a tax reform removing the Danish top and middle income tax brackets (*topskat* and *mellemskat*) is simulated, rendering a flat tax schedule with a single marginal tax rate of approximately 43 per cent.[18] This reform would entail a mechanical revenue loss of 24 billion *kroner* and is therefore not comparable to the tax reforms normalized to mechanical revenue losses of 1 billion *kroner* discussed above. Moreover, the effects of tax reforms increase non-linearly with the size of the tax changes, as discussed in section 3.2.

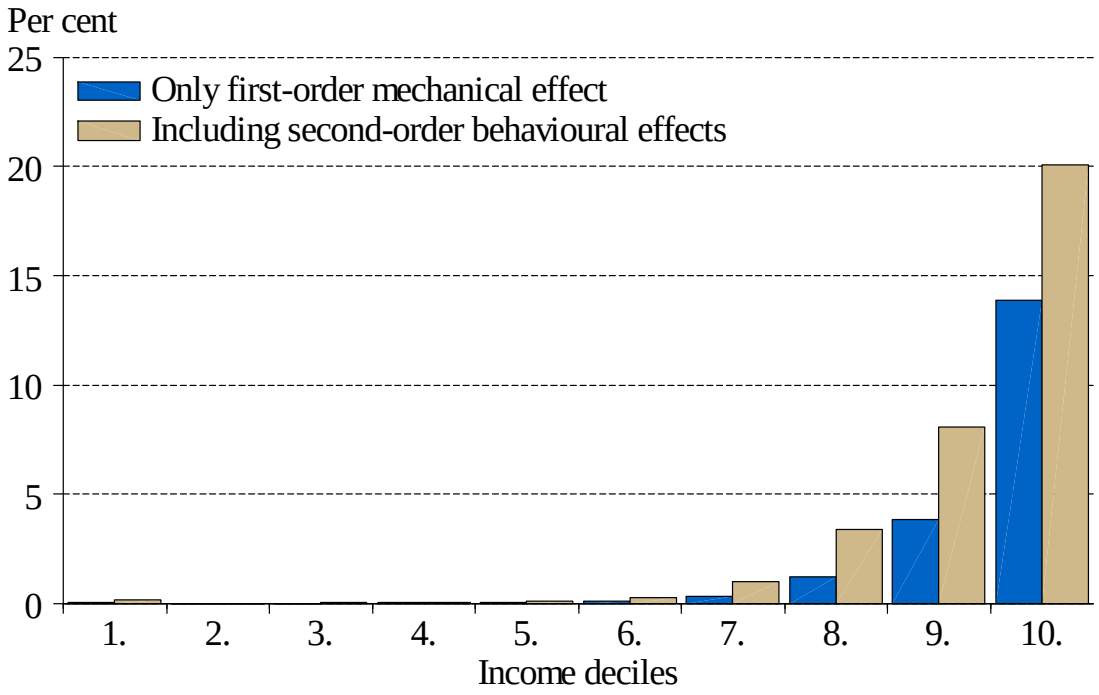
The abolition of the top and middle income tax brackets would lead to an increase in yearly working hours equivalent to almost 30,000 full-time employed persons, almost exclusively among the full-time employees who would experience an increase in their after-tax wage rate of 14.7 per cent. The flat tax reform would only induce approximately 130 unemployed individuals to gain employment. This low number reflects the fact that the majority of

[18] The simulated "flat tax" consists of a gross tax of 8 per cent, a municipal tax of 25.1 per cent, on average, two state tax brackets of 8 and 5.04 per cent and a negative marginal tax rate from an employment allowance.

people out of work face potential labour incomes with a low exposure to the progressive tax brackets. However, the large behavioural effects of the flat tax experiment on the intensive margin induces a dynamic revenue effect of approximately 10 billion *kroner*, yielding a revenue recovery rate of 42 per cent.

The distributional impact of the introduction of a flat tax regime is regressive, as only the upper half, and particularly the top decile, of the income distribution gains from the reduction in the effective tax rate (figure 7). The top income decile would record an increase in their after tax income of almost 15 per cent from the first-order mechanical effect of the tax reduction, increasing to 20 per cent with the second-order behavioural effects included.[19]

Figure 7: Distributional effects of a flat tax-reform



Note: Income deciles are calculated for after tax incomes. The figure is not comparable to figure 5 and figure 6, as the magnitude of the tax reforms analyzed is different.

6.4 Further tax experiments

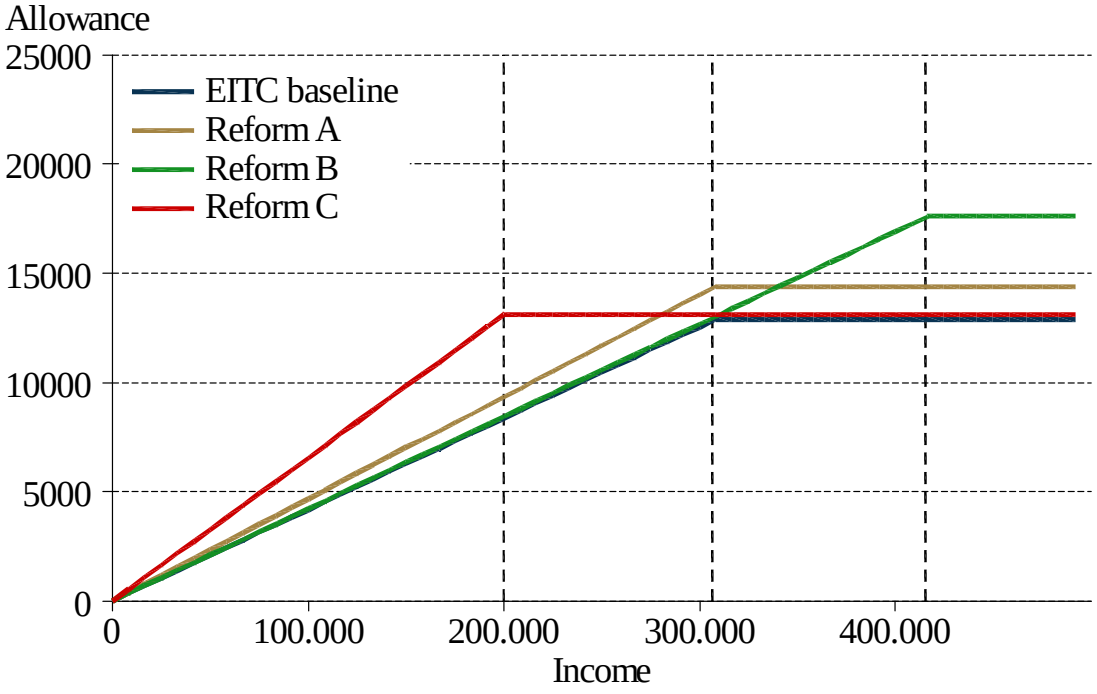
The examination of the economic incentives at the intensive and the extensive margin in section 5 showed the considerable heterogeneity in labour market incentives. The three tax experiments discussed above likewise demonstrated strongly diverging effects on labour supply and the income distribution. Earlier analyses using MILASMEC presented in The Economic Councils (2008) confirm the highly variable effects of different tax reform designs.

[19] See footnote 17 for an explanation of the slight income gains in deciles one to five.

The Economic Councils (2008) presented the results of an increase in the top tax threshold by 10,000 *kroner*, with a mechanical revenue loss of 1.2 billion *kroner*. This reform would affect only around 100,000 individuals, compared to the 1 million who would benefit from the top tax rate reduction described in section 6.2. However, individuals with labour incomes between the old and the new threshold would experience a tax reduction of not 1 but 15 percentage points, with the following larger increase in the wage rate. The overall behavioural effect is thus larger than for the top tax rate reduction, rendering a revenue recovery rate of 63 per cent (table 8).

In another suite of simulations, The Economic Councils (2008) examined three different reforms of the earned income tax credit. To increase the economic gains from employment, the Danish EITC offers a negative marginal tax rate of, currently, 4.25 per cent on labour income, with a maximum allowance of 13,600 *kroner*, corresponding to an income threshold of just over 300,000 *kroner*, beyond which the maximum allowance sets in (figure 8). Thus, below this threshold the EITC affects the marginal tax rate on labour income, while it constitutes a fixed employment allowance above the threshold. Hence, varying the design of changes in the EITC for a given mechanical revenue loss of approximately 1 billion *kroner* yields strong differences in the effects, see table 8 and The Economic Councils (2008).

Figure 8: Reforms of the Danish earned income tax credit



Reform A for the change of the EITC, with a higher negative marginal tax rate and a higher maximum allowance, reduces the marginal tax rate for all

those below the income threshold, while increasing the economic gain to employment for everyone. This yields a total increase in labour supply of approximately 600 full-time employees, rendering a revenue recovery rate of 13 per cent. Reform B with a higher maximum allowance and, correspondingly, a higher income threshold of over around 417,000 *kroner* reduces the marginal tax rate for those who are between the old and the new income thresholds, resembling the increase in the top tax threshold (section 6.2). However, the relative change in the marginal wage rate is lower, yielding a lower revenue recovery rate of 34 per cent. Reform C for a change in the EITC channels the full mechanical revenue loss to an increase in the negative marginal tax rate, with an unchanged maximum allowance and a new threshold of 200,000 *kroner*. This reform would benefit the lowest part of the income distribution through lower marginal taxes and a higher economic gain to employment, but also would hurt individuals with labour incomes between the old and the new income thresholds, since their marginal tax rate would rise. So, overall this reform would entail a reduction in the labour supply, and a negative revenue recovery rate of -4 per cent, i.e. an increase in the public revenue loss from the behavioural dynamic effects.

6.5 The overall trade-off between equity and efficiency

The simulations reviewed above reveal stark differences in the labour market outcomes and the distributional consequences of tax reforms depending on the specific design of the change.[20] Revenue recovery rates as a summary statistic for the effects on both labour supply and public finances varied from -4 per cent for reform C of the earned income tax credit to 63 per cent for an increase of the income threshold for the top marginal tax rate. This measure of the efficiency effect of tax reforms is also correlated with the net public costs per additional worker, when both the mechanical and dynamic effects of a tax reform are accounted for. The additional labour supply generated by an increase of the top tax threshold would cost 175,000 *kroner* per worker, while the labour supply effect from the reduction of the labour market contribution would cost 1.9 million *kroner* per worker.

[20] This comparison of the tax reforms presented here excludes the flat tax simulation, as this simulation, unlike the remaining ones, is not normalised to a mechanical revenue loss of approximately 1 billion *kroner*.

Table 8: Revenue recovery rate, distributional effects and costs per worker

	Revenue recovery rate	**Costs per extra employee**	**Change in Gini-coeff.**
	Per cent	1.000 DKK	Per cent
Reduction in labour market contr.	10	1,870	0.03
Reduction in top tax rate	57	265	0.35
Increase of top tax threshold	63	175	0.25
Earned Income Tax Credit, reform A	13	1,685	-0.03
Earned Income Tax Credit, reform B	34	405	0.24
Earned Income Tax Credit, reform C	-4	-	-0.20

Source: Own calculations and The Economic Councils (2008)

The distributional consequences of tax reforms can be summarised by the change in the Gini-coefficient which increases with a more unequal income distribution. By this measure a reduction in the top tax rate would be the most regressive tax reform among those analyzed, with an increase in the Gini-coefficient of 0.35 per cent. A reduction in the gross marginal tax rate would benefit everyone and would only lead to a slight increase in the Gini-coefficient of 0.03 per cent. The most progressive tax reform would be reform C of the earned income tax credit, which only benefited the lower part of the income distribution. This reform would lead to a more equal income distribution with a decrease in the Gini-coefficient of 0.20 per cent.

In broad terms, the overall conclusion from comparing the tax reforms in table 8 is that there is a rather strict trade-off between efficiency and equity in the design of tax reforms. Reforms with strong labour supply effects and low net effects on public finances have been shown to be regressive, as they build on tax reductions in the top of the income distribution, while broad tax reductions or tax reductions that focus on the lower part of the income distribution have weaker labour supply effects.

7. Concluding remarks

Denmark faces a projected decline in the labour force and increased international competition for labour and this has motivated an examination of the Danish tax structure and its impact on labour supply. For this purpose the model MILASMEC – MIcro data LAbour Supply Model of the Economic Councils – was developed in 2008. The model reproduces the economic incentives for the supply of hours and labour market participation and calculates the change in these economic incentives for hypothetical changes in the tax system. This allows the computation of the labour supply effects of tax re-

forms, as well as their distributional impacts. The paper has documented the considerable heterogeneity in the work force with respect to both labour supply and the incentives to participate in the labour market or to alter the number of hours worked. In MILASMEC the labour supply responses are differentiated among a number of population groups, to reflect this underlying heterogeneity.

As an illustration, a number of tax reforms are simulated, illustrating the variation in labour supply outcomes and public revenue effects from different designs of tax changes. While a small reduction in the top marginal tax rate has a revenue recovery rate of 57 per cent, a reduction in a broad, gross marginal tax rate with an equal first-order revenue effect only musters a revenue recovery rate of 10 per cent. However, the higher efficiency gain from tax cuts in the upper end of the income distribution come at the price of a far more regressive distributional impact. This trade-off in tax reforms between equity and efficiency is confirmed in the discussion of a number of other tax changes simulated in MILASMEC.

References

Blundell, R. and T. MaCurdy (1999): Labor Supply: A Review of Alternative Approaches. I: Ashenfelter, O. og D. Card (red.): *Handbook of Labor Economics*. Elsevier Science B.V.

Chetty, R. (2008): Moral Hazard versus Liquidity and Optimal Unemployment Insurance. *Journal of Political Economy*, 116 (2), p. 173-234.

DREAM (2008): Danish Rational Economic Agent Model - Documentation - Chapter 5 Households. http://www.dreammodel.dk/pdf/Households.pdf.

Frederiksen, A., E.K. Graversen and N. Smith (2001): Overtime Work, Dual Job Holding and Taxation. IZA Discussion Paper Series No. 323. Institute for the Study of Labor.

Frederiksen, A., E.K. Graversen and N. Smith (2008): Overtime Work, Dual Job Holding and Taxation. *Research in Labour Economics*, 28 , p. 25-55.

Hansson, Å. (2004): Taxpayers Responsiveness to tax rate changes and implications for the cost of taxation in Sweden. *International Tax and Public Finance*, 14 (5), p. 563-582.

Heckman, J.J. (1976): The Common Structure of Statistical Models of Truncation, Sample Selection, and Limited Dependent Variables and a Simple Estimator for Such Models. *Annals of Economic and Statistical Measurement*, 5 , p. 475-492.

Holmlund, B. and M. Söderström (2007): Estimating Income Responses to Tax Changes: A Dynamic Panel Data Approach. IZA Discussion Paper No. 3088. Institute for the Study of Labor.

Keen, M., Y. Kim and R. Varsano (2008): The "flat tax(es)": principles and experience. *International Tax and Public Finance*, 15 (6), p. 712-751.

Kleven, H.J. and C.T. Kreiner (2006a): Arbejdsudbud, provenueffekter og Laffer-kurve. I: Tranæs, T. (red.): *Skat, arbejde og Lighed*. Rockwool Fondens Forskningsenhed, Gyldendal.

Kleven, H.J. and C.T. Kreiner (2006b): The marginal cost of public funds: Hours of work versus labor force participation. *Journal of Public Economics*, 90 (10), p. 1955-1973.

Kleven, H.J. and E.A. Schultz (2009): Estimating Reported Income Responses using Danish Tax Reforms.

le Maire, D. and C. Scheuer (2008): Determinants of Labor Force Participation for Recipients of Social Assistance: An Panel Data Analysis for Denmark.

Ljunge, M. and K. Ragan (2005): Labor Supply and the Tax Reform of the Century.

Meghir, C. and D. Phillips (2008): Labour Supply and Taxes. IZA DP No. 3405. Institute for the Study of Labor.

Ministry of Finance (2002): *Fordeling og Incitamenter 2002*. www.fm.dk.

Ministry of Finance (2004): *Fordeling og Incitamenter 2004*. www.fm.dk.

Saez, E. (2002): Optimal Income Transfer Programs: Intensive versus Extensive Labor Supply Responses. *The Quarterly Journal of Economics*, 117 (3), p. 1039-1073.

Skatteministeriet (2008): Rapport om Skatternes Økonomiske Virkning (StØV).

Sørensen, P.B. and J.R. Skaksen (2007): Skattepolitikken og Arbejdsmarkedet. *Økonomi og Politik*, 4 .

Statistics Denmark (2007): *StatBank Denmark, Working Time Account by industry (ATR1)*.

Statistics Denmark (2008): Indkomst, Forbrug og Priser. Consumer Survey 2004-2006. Statistiske Efterretninger 2008:8.

The Economic Council (2004): *Danish Economy, Autumn 2004*. (in Danish only, with english summary).

The Economic Councils (2008): Taxation of labour income. I: *Danish Economy, Autumn 2008*. (in Danish only, with English summary).

The Economic Councils (2010): Long-term projections for the Danish Economy (to be published). I: *Danish Economy, Spring 2010*.

Appendix A

Equation (3.6) can be derived as follows.[21] First, equation (3.5) can be rewritten as

$$\Delta u = \alpha \cdot \Delta K$$

$$\Delta \frac{U}{W} = \frac{\Delta U}{W} = \alpha \cdot \Delta K$$

$$\Delta U = \alpha \cdot \Delta K \cdot W$$

$$\frac{\Delta U}{U} = \alpha \cdot \Delta K \cdot \frac{W}{U}$$

$$\frac{\Delta U}{U} = \alpha \cdot \Delta K \cdot \frac{1}{u} \qquad \textbf{(A1)}$$

Now defining (after-tax) income in employment and unemployment as I_B and I_U, respectively, the economic gain to employment, G, can be stated as G = I_L - I_U, while the replacement rate, K, is K = I_U/I_L. Combining this, we can write[22]

$$G = I_L - I_U = I_L - I_L K = I_L (1-K) \qquad \textbf{(A2)}$$

Defining $\Delta G = G'-G$ and $\Delta K = K'-K$, it then holds that

$$\frac{G'-G}{G} = \frac{I_L(1-K') - I_L(1-K)}{I_L(1-K)} = \frac{K-K'}{1-K} \qquad \textbf{(A3)}$$

and thus $$\Delta K = \frac{\Delta G}{G}(1-K) \qquad \textbf{(A4)}$$

Entering this expression into equation (A1) yields equation (3.6),

$$\frac{\Delta U}{U} = \frac{\Delta G}{G} \cdot \alpha \cdot (1-K) \cdot \frac{1}{u} \qquad \textbf{(A5)}$$

[21] This derivation is joint work with Dorte Grinderslev.

[22] For this derivation the definition of G as $G = I_L - I_U$, is equivalent to equation (3.3). Normalising equation (3.3) by $(1-t_d)/(1-t_c)$, it can be written as $G = xI_L - I_U$, where x is a function of the tax rates. The factor x subsequently cancels out in expression (A3).