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Working Papers

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By John K. Dagsvik, Marilena Locatelli and Steinar Strøm

ChilD n. 01/2006

e-mail: de-child@unito.it
Web site: http://www.child-centre.it

December 15, 2005

Simulating labor supply behaviour when workers have preferences over job opportunities and face non-linear budget constraints.

By John K. Dagsvik[1], Marilena Locatelli[2] and Steinar Strøm[3,4]

Abstract

A female labor supplied model including sectoral choice, estimated on data from Norway, 1994 has been used in simulation to yield labor supply elasticities. We find that these elasticities are declining with the wage level of the women. The overall elasticities are rather small, but these small elasticities shadow for much stronger sectoral responses. A wage increase gives the women an incentive to shift labor supply from the public to the private sector. This occurs despite the fact that education and experiences have a slightly higher return in the public than in the private sector. The reasons for our result are that in the private sector wages are more dispersed and hours are less regulated. Marginal tax rates were cut considerably in the 1992 tax reform. We find that the impact on overall labor supply is rather modest, but again these modest changes shadow for stronger sectoral changes. The tax reform stimulated the women to shift their labor from the public to the private sector and to work longer hours. A calculation of the expected value of changes in household welfare shows that the richest households benefited far more from the 1992 tax reform than the poorest household.

JEL classification: J22, C 51
Keywords: Labor supply, married females, structural model, sectoral choice, wage ealsticities, evaluation of tax reforms

[1] Statistics Norway and the Frisch Centre, Oslo
[2] University of Turin, CHILD, Turin and the Frisch Centre, Oslo
[3] University of Turin, CHILD, Turin, University of Oslo, and the Frisch Centre, Oslo, steinar.strom@econ.uio.no
[4] We acknowledge financial support from the Research Council of Norway. We are grateful for comments given by participants at the Australian Conference for Economists, Sept, 2005 and at the CHILD seminar in Turin, Nov 2005.

1. Introduction

Policy reforms involve many complexities. To sort out and assess important aspects and effects from policy interventions beyond popular beliefs, models are inescapable. One can distinguish between non-behavioral and behavioral models. The advantage with the former type of models is that they are more straightforward to build and maintain than behavioral models. The disadvantage is that they do not give answers to most of the questions raised in the political debate: Will a suggested tax reform stimulate labor supply? Who loses and who gains from the reform? When behavioral responses are accounted for, what are the impacts on tax revenue? Will a cut in tax rates increase revenues?[5]

The problem with applying behavioral models is, however, that there seems to be no general agreement among researchers on how such models should be constructed. In this paper we report simulations results from a variety of policy reform experiments, based on a particular behavioral model, developed and estimated by Dagsvik and Strøm (2006). We argue that the modeling approach in Dagsvik and Strøm (2006) comprises some desirable features, to be summarized below, that have previously been neglected in alternative modeling approaches in the literature.

Since Ashenfelter and Heckman (1974) and Heckman (1974a and 1974b) empirical labor supply models have been embedded in a structural behavioral framework. One important extension of this line of research was made by Burtless and Hausman (1978), in which a method was proposed which explicitly accounted for the entire budget constraint generated by non-proportional tax rules. That paper and others by Hausman led to an outpouring of empirical research based on his approach, see Blundel and MaCurdy (1999) for a survey of these studies. In this and also in more recent work in labor supply, van Soest et al (2002), it is assumed that the choice variable is hours of work, which can be chosen freely in the market. Wage rates are given by human capital characteristics, and together with the chosen hours of work and the tax structure facing the agents, the disposable household incomes follow. Thus leisure and disposable income are the sole determinants behind labor supply. There are four major problems with this type of modeling labor supply.

First, daily life experiences suggest that hours of work and the implied wage income are only two out of several job-related attributes that affect the individuals' behavior in the labor market. Type of job and other non-pecuniary job-attributes may matter a great deal for the chosen labor market affiliation of the individuals. Some jobs may be more interesting and challenging than other jobs and to explain the long working hours among scientists and government bureaucrats solely with a reference to after tax wage rates may be quite misleading.

Second, to assume that hours of work can be freely chosen implies that offered hours in the market is uniformly distributed, which often is assumed for a perfect competitive economy. Yet, an important characteristic of labor markets throughout the industrialized world is that hours of work are fixed for many types of jobs. This is due to firm technology, government regulations and/or the outcome of negotiations between unions and employers associations in unionized economies. Thus if an individual like to change

[5] See Creedy et al (2002) for further discussion and arguments in favor of behavioral models.

his or her working load he or she has either to change job or to change the content of the occupied job, see Altonji and Paxon (1988) for findings that support this view.

Third, to assume that wage rates are determined by human characteristics contradicts again daily life experiences and the findings in Krueger and Summers (1988) and Edin and Zetterberg (1992). Observationally identical individuals may have different wage rates per hour dependent on what job they have. Thus in modeling labor supply one should allow for job-specific wage rates.

Finally, an important element in the modeling of labor supply variations is heterogeneity. Responses to changes in tax rules may differ to a great extent across households and individuals. We would expect that a low skilled married woman, married to a man with high income, and with small children, respond less to economic incentives than a low-skilled woman with no children and married to a man with low income. To account for differences in socio-demographic characteristic can thus be of great importance in the assessment of how changes in tax rules affect labor supply and household welfare, see Atkinson (1995). What seems to have been neglected when heterogeneity is introduced is that type of job and sector affiliations also may matter for labor supply responses when tax systems are changed. One would expect that the more interesting and challenging a job is, the less important is the net wage (above a certain level). Those who have these types of jobs are not randomly chosen in the population; they tend to be well educated, with high wage incomes, and their spouse may also fit the same characteristics. If this is so, then this may have strong implications for how tax rules should be changed to stimulate labor supply. Improved economic incentives should be targeted against those who respond, not necessarily against those with the highest education level and highest income and facing the highest marginal tax rates.

To capture these four aspects of the labor markets we have developed a model where labor supply behavior is considered to follow from the individuals' choice of job "packages". Each of these job "packages" is characterized by an offered wage, offered hours of work and non-pecuniary attributes. The individual specific choice sets of job "packages" may be thought of as being determined by employers or by negotiations between employers association and unions and they are thus exogenous to the individuals. Some of the non-pecuniary attributes are unobservable and to the analyst the choice sets are thus stochastic. The individual has preferences over leisure, disposable income and the non-pecuniary attributes. The effects of unobserved characteristics of the jobs on preferences imply that for the analyst preferences are random. Thus our model allows for unobserved heterogeneity in tastes as well as in job opportunities. A novel feature of our model, which also brings in job attributes beyond hours and wages, is that it explicitly account for the choice of sectors. Here we distinguish between working in the public and the private sector, but the model can easily be extended to deal with multi-sectoral choice. Wage rates are allowed to be sector specific, which, as mentioned above, is at odds with what is normally assumed in labor supply studies.

The sector dimension of the model allows us to go beyond overall labor supply responses to changes in wages and tax rates. Our hypothesis is that although overall labor supply may be rather inelastic, these modest labor supply responses may shadow for stronger responses with respect to sectoral choice. Highly educated women are often found working in the public sectors in a welfare state such as the Norwegian. Job security is higher than in the private sector, human capital seems to be priced slightly higher and

the public sector may offer better opportunities to find subsidized child care facilities. On the other hand, in the private sector wages are more dispersed and hours are less regulated. We should thus expect that stronger incentives to work longer hours, like higher wages or lower marginal tax rates, may have an impact on the sectoral choice of working women. Higher wages, in particular in the private sector, or lower marginal tax rates, may give women an incentive to shift labor supply away from the public towards the private sector. A typical example is a part-time working nurse or a medical doctor in a public hospital who shifts her labor to a private clinic with longer working hours. However, the income of the spouse may affect the choice of the wife and we should remember that the matching in the marriage market is not random. Typically, a woman with a high potential wage in the market is married to a man with similar opportunities.

The theoretical model is described in details in Dagsvik and Strøm (2006). Here we will employ the model to assess labor supply elasticities, overall and across sectors, and to evaluate policy interventions, in particular tax reforms. The household welfare evaluation of the tax reforms is based on the calculation of the expected value of compensating variation using the whole structure of the random utility model, not only the deterministic parts. This evaluation is based on a procedure suggested in Dagsvik and Karlstrøm (2005) in which the expected value of compensating variations is derived within a random utility model and where utility is a non-linear function of income.

In the 1980s and early 1990s many OECD countries reformed their tax systems. Progressive tax schedules were changed towards proportional taxation. Marginal tax rates were cut, in particular on high incomes. The Norwegian tax reform we analyze here was similar and took place in 1992. The top marginal tax rate on wage income was reduced from 0.654 to 0.495. Our analysis show that this sharp reduction in marginal tax rates stimulates overall labor supply to some minor extent, but it gives the married women an incentive to shift their labor from the public sector to the private sector where hours are less constrained and wage dispersion is higher. Despite that labor supply increases, which enlarges the tax base, tax revenues is reduced. Laffer curve problems seems not to have been an issue even in the highly tax progressive Scandinavian welfare states. Who gained and who lost from the 1992 tax reform? In household welfare terms the rich gained far more than the poor.

The paper is organized as follows. In the next section the model is briefly explained, estimates are reported in Section 3. Labor supply elasticities are reported and interpreted in Section 4. In Section 5 we present the impacts on labor supply of replacing the constraints on offered hours by uniformly distributed hours. Two tax reforms are discussed in Sections 6 and 7. Section 8 concludes.

2. The modeling framework

2.1 Choice probabilities, heterogeneity and labor supply

In what follows we give a simplified description of the model. For more details and for justifications of the assumption made we refer to Dagsvik and Strøm (2006) and Dagsvik and Strøm (2003). The present paper is about labor supply of married and cohabiting women. The labor supply and hence the wage income of the husband is exogenously

given. However, the model can easily be extended to deal with the joint labor supply of husbands and wives. Our justification for focusing on married women is that previous and numerous studies have shown that their labor supply is far more responsive to changes in economic incentives than for married men.

For expository reasons we start with assuming that the agent can choose between jobs in one sector and not working. Later we will show how the model can be extended to deal with choice of jobs in different sectors of the economy.

The household is assumed to derive utility from household consumption, here set equal to household disposable income, leisure and non-pecuniary attributes of jobs. U(C,h,z) is the utility function of a household. C is disposable household income; h is hours of work of the married woman. z indexes jobs, z =0,1,2,3,,, and where z =0 implies not working. z is an enumeration of jobs.

For given hours of work h and wage rate w, disposable household income is given by

$$(1) \quad C = f(hw, I)$$

f(.) is a function that transforms the pre-tax incomes into after tax incomes. The pre-tax incomes are the wage income of the married female (hw) and three incomes in the vector I. These three incomes are the wage income of the husband, the capital income of the household and child allowances, which vary with the number of children up to the age of 18. Child allowances are not taxed. All details of the tax structure are taken into account when the model is estimated. The tax functions of wage income in 1994, as well as child allowances are given in Appendix B. From there we note that the tax functions differ according to if both spouses are working or not. Capital income is taxed at a flat rate of 0.28.

The reason why the index z enters the utility function is that there might be job-specific factors beyond wage and hours of work that can affect the utility of the agents. Examples are free access to newspapers, Internet, stimulating colleagues, location of the work place and subsidized kindergarten. In principle some of these job-specific factors can be observed, but it is obvious that the econometricians analyzing labor market data can hardly observe many of them. The assessments of these unobserved job-specific factors may vary across agents. Thus, as outside observers we have to assume that the utility function is random. We will assume that the utility function has the structure

$$(2) \quad U(C, h, z)=v(C,h)\varepsilon(z), \text{ for } z=0,1,2,3,,,$$

where v(.) is a deterministic function and $\varepsilon(z)$ is a positive random taste shifter. The taste shifter accounts for unobserved individual characteristics and unobserved job-specific attributes. $\{\varepsilon(z)\}$, are independently distributed with c.d.f. $\exp(-x^{-1})$, $x>0$.

For the outside observer the choice sets of the agent cannot be fully known. The choice sets will therefore be random. To simplify expositions we will first ignore heterogeneity in opportunity sets. Later we will briefly discuss how the model can be extended to handle observed and unobserved heterogeneous choice sets.

Let D(h,w) denote the agent's sets of available jobs with offered hours of work h and offered wage rate w. Let m(h,w) be the number of jobs in the choice set D(h,w); thus

$z \in D(h,w)$. For the not working alternative the choice set is D(0,0) and by convention we set m(0,0)=1.

Assumptions made above allow us to derive the probability that an agent will choose a job with wage rate w and hours of work h within the choice set D(h,w). It has been demonstrated for example by McFadden (1984) that if the agent is an utility maximizer, then the probability that a **specific** job, say a job z within the choice set D(h,w) is chosen, is given by

$$(3)\quad P[\psi(h,w;I)\varepsilon(z) = \max_{x,y} \max_{k\in D(x,y)}(\psi(x,y;I)\varepsilon(k)] = \frac{\psi(h,w;I)}{\sum_{x,y}\sum_{k\in D(x,y)}\psi(x,y;I)}$$

where

$$(4)\quad \psi(h,w;I) = v(f(hw;I),h)\,.$$

Due to the assumption of homogenous choice sets with m(h,w) number of jobs with hours of work h and wage rate w within the choice set D(h,w), the probability in (3) can be written to yield

$$(5)\quad \frac{\psi(h,w;I)}{\sum_{x,y}\sum_{k\in D(x,y)}\psi(x,y;I)} = \frac{\psi(h,w;I)}{\sum_{x,y} m(x,y)\psi(x,y;I)}\,.$$

Let φ(h,w;I) denote the probability of choosing **any** job within the choice set D(h,w). Obviously, this must be the sum of the probabilities of choosing specific jobs in the choice set D(h,w), summed over all jobs in this choice set. From (3) and (5) we then get

$$(6)\quad \varphi(h,w;I) = \sum_{z\in D(h,w)} P[\psi(h,w;I)\varepsilon(z) = \max_{x,y}\max_{k\in D(x,y)}(\psi(x,y;I)\varepsilon(k)]$$
$$= \sum_{z\in D(h,w)} \frac{\psi(h,w;I)}{\sum_{x,y} m(x,y)\psi(x,y;I)} = \frac{m(h,w)\psi(h,w;I)}{\psi(0,0;I) + \sum_{(x,y)>0} m(x,y)\psi(x,y;I)}$$

Note that the choice probability of not working, φ(0,0;I) follows from (6) by setting m(0,0)=1 in the numerator.

We note that the numerator in the choice probability in (6) can be interpreted as the value of how attractive a job with hours of work h and wage rate w is (the ψ(.) term), weighted with how many jobs there are in the market with these characteristics (the m(.) term). The denominator gives the weighted value in utility terms of all feasible jobs, including the option of not working.

To proceed towards the empirical model we first assume that the choice probabilities are conditional on the wage rates. We are thus not modeling the simultaneous choice of jobs, hours and wages as implied by (6). We simplify the choices to deal with the choice of jobs and hours, only. Next we assume that the agent can choose

between working in the public and the private sector, and of course, also not to work at all.

Availability of jobs in the two sectors is allowed to vary across the two sectors and also across human capital characteristics of the agents. For many reasons, most women are working in the service branch of the economy. In Norway, most of the services are provided by the public sector (health services, education etc) and many of these jobs require higher education, while the services provided in the private sector say, in retail sale, are typically based on low-skill labor. Hence we will assume that the availability of jobs in the two sectors depends on education level.

We assume offered hours of work to be uniformly distributed, except at full-time and part-time hours. At these two points there are spikes in the distribution, which represent the fact that in an unionized and government regulated economy like the Norwegian there are more available jobs with part-time and full-time hours of work than with other hours. This assumption implies that when we observe many working say, full-time, rushing to the job at 7am and rushing back home at 5pm, it may be due to constraints on offered hours in the market rather than that individuals prefer to have the exact same working load.

It should be noted that our approach of weighting the utility value of a job in the choice probabilities with the availability of certain offered hours and jobs are justified with a reference to how the labor markets are organized and regulated. A change in these institutional constraints in the labor market will change the labor supply probabilities. These eventual changes are driven by changes in demand side factors (firm technology) and/or labor market institutions (government regulation or outcomes about working hours in the negotiations between unions and employers' associations) and not by changes in preferences. Our approach should be contrasted with the *ad hoc* approach of van Soest (1995) and Callan and van Soest (1996) who include a penalty rate for particular hours in the utility function so that the probability at these hours points are reduced, see Creedy and Kalb (2005) for a further discussion. In the approach of van Soest (1995) a change in labor market institutions or firm technology that changes the constraints on hours offered in the market will falsely be attributed to change in preferences.

We would expect that offered hours in the public sector are more concentrated at full-time hours than in the private sector. The unions are stronger with a much higher coverage in the public than in the private sector. Recall that uniformly distributed offered hours corresponds to the notion of a perfect competitive economy. Offered hours are discrete and fall within 7 intervals. The medians of the intervals range from 715 annual hours to 2600 annual hours. The mid points in the interval for part-time and full-time jobs are 1040 and 1976 annual hours, respectively.

Wage rates are assumed to depend on human capital characteristics like working experience and education. Both the levels and the return to human capital are allowed to vary between the public and the private sector. To allow for unobserved heterogeneity in opportunities we introduce random effects in wages. The expectations of these random effects are zero in both sectors. The variances may vary across sectors, which means that wage dispersion is allowed to vary between the public and the private sector.

To account for these assumptions we have to rewrite the choice probabilities in (6). To do so we need some new notation. In the first place the subscript j indicates sector, j=0,1,2. The public sector is sector 1 and the private sector is sector 2. Not working is

"sector" j=0.w_j denotes the wage level in sector j and equals $w^*_j\eta_j$, where w^*_j depends on human capital variables and η_j is the random effect. The density of offered hours is denoted $g_j(h)$. It is assumed uniform except for peaks at full-time and part-time hours. Availability of jobs in the two sectors is denoted b_j. The choice probabilities that correspond to the ones in (6), denoted $\varphi_j(.)$, are then:

$$(7)\ \varphi_j(h, w^*_1\eta_1, w^*_2; I) = \frac{\psi(h, w^*_j\eta_j; I,)g_j(h)b_j}{\psi(0,0;I) + \sum_{k=1}^{2} b_k \sum_{x>0} \psi(x, w^*_k\eta_k; I)g_k(x)b_k};$$

for $h > 0, j = 1, 2;$

and

$$(8)\ \varphi_j(0, w^*_1\eta_1, w^*_2; I) = \frac{\psi(0,0;I)}{\psi(0,0;I) + \sum_{k=1}^{2} b_k \sum_{x>0} \psi(x, w^*_k\eta_k; I)g_k(x)b_k},$$

for $h = 0.$

From (7) and (8) we observe that the choice probabilities depend on the random variables $\{\eta_1, \eta_2\}$. We assume that log η_j, j=1,2, are independent and normally distributed with zero expectations and variances σ_j^2 .To represent the choice sets when the model is estimated or used in policy simulation, we draw from the distribution of η_j, j=1,2. i.e. we make 50x50=2500 draws from the distribution of $\{\eta_1,\eta_2\}$ for each individual. By taking the average of φ_j over these 2500 draws we obtain the average choice probabilities $\overline{\varphi}_j$, which can be interpreted as the choice probabilities where the unobserved heterogeneity in the choice sets is integrated out.

2.2 Empirical specifications

The wage equations

We assume that the log wage rates vary across sectors and individuals and that it depends on experience (defined as age minus years of education and minus six), experience squared and education level. The wage equations are estimated separately in a two-step procedure, where in the first step the probability of working in sector j, q_j, j=0,1,2, is estimated (reduced form estimates), and then log(q_j) is used as a covariate in estimating the wage equation. The latter is done to control for selectivity. The reason why log(q_j) is the proper selection variable, is that the choice probabilities are multinomial probabilities, for more details see Dagsvik and Strøm (2006). The estimated wage equations are given in Appendix C. From the results given there we observe that the wage level, given the observed covariates, is predicted to be slightly higher in the private sector than in the

public sector. On the other hand, human capital variables like experience and education are slightly higher priced out in the public than in the private sector. From the estimates given in Appendix C we observe that σ_1 is estimated to $\sqrt{0.059}= 0.243$ and σ_2 is estimated to $\sqrt{0.075}=0.274$. Thus the wage level, as well as the dispersion in wages, is higher in the private sector than in the public sector, while observed human capital is higher priced out in the public sector.

The availability of jobs

We assume that the availability of jobs b_j is given by:

$$\log b_j = f_{j1} + f_{j2}S \; ; j=1,2 \tag{9}$$

S is the length of education.

The deterministic part of the utility function

The functional form of the deterministic part of the utility function is a critical issue in empirical labor supply. In the Hausman approach labor supply is assumed to be continuous and a linear function of after-tax wage rates and virtual income, the latter is needed to account for non-proportional taxation. For statistical reasons one then has to impose constraints that guarantee positive uncompensated substitution effects, which may lead to upward biased substitution effects and downward biased income effects, see MaCurdy et al (1990) and Heim and Meier (2003). To handle these constraints in a maximum likelihood estimation is also cumbersome. Moreover by assuming that labor supply is a linear function of after-tax wage rates and virtual income one imposes the constraint that labor supply becomes more elastic the higher the wage rate is. Thus, by assumptions individuals with high potential high wages and consequently potential high incomes become more sensitive to changes in income incentives than individuals with lower labor market potentials, and hence by assumptions, efficiency gains may be realized by cutting tax rates at the top.

By specifying the indirect utility function directly it is easier to check for the quasi-concavity of the utility function. However the class of feasible functional form is infinitely large. In recent studies it has therefore been supposed that the best one can do is to approximate the unknown form of the utility function with a polynomial in disposable income and leisure and to let data determine the degree of the polynomial, for example as in van Soest et al (2002). The problem with this approach is that there is no guarantee that the empirical results are consistent with the behavioral assumptions. In Dagsvik and Strøm (2006) it is shown that the utility maximizing model, based on a flexible functional form of the utility function, proposed in van Soest et al, op cit., and estimated on cross-section data, implies non-convex preferences. The empirical results are thus in conflict with the utility maximizing assumptions in the model that give rise to the structure of the choice probabilities estimated on data.

To let the functional form problem be solved by data is not the way to do it. The reason is that without theoretical principles any form is a priori possible. To identify the

correct one from observed labor market data is an impossible task because of measurement problems and unobserved variables. Our paper is therefore based on an axiomatic justification of the functional form of the deterministic part of the utility function as well as of the distribution of the taste shifters in the random utility functions. For further details see Dagsvik and Strøm (2006).

In accordance with the results of the axioms in Dagsvik and Strøm (2006) $\log v(\cdot)$ has the following form:

(10)

$$\log v(C,h) = \alpha_2\left(\frac{[10^{-4}(C-C_0)]^{\alpha_1}-1}{\alpha_1}\right)+\left(\frac{(L-L_0)^{\alpha_3}-1}{\alpha_3}\right)\left(\alpha_4+\alpha_5\log A+\alpha_6(\log A)^2+\alpha_7 CU6+\alpha_8 CO6\right)$$
$$+\alpha_9\left(\frac{[10^{-4}(C-C_0)]^{\alpha_1}-1}{\alpha_1}\right)\left(\frac{(L-L_0)^{\alpha_3}-1}{\alpha_3}\right)$$

where A, is the age of the married woman, CU6 and CO6 are the number of children less than 6 and above 6 years, C is given by $f(hw,I)$, L is leisure, defined as

(11) $$L - L_0 = 1 - h/3640,$$

and α_j, $j=1,2,...,9$, are unknown parameters. Observe that we have subtracted from total annual hours a "subsistence" level, amounting to 5120 hours, which corresponds to about 14 hours per day reserved for sleep and rest.

Consistent with psychophysical evidence, we have also introduced a subsistence threshold level, C_0 for consumption in the $v(\cdot)$ function. We have chosen C_0 to be close to the official estimate of a subsistence level in Norway (NOK 60 000)[6]. C is measured as the sum of the annual wage income of the woman and her husband after tax, household capital income after tax and child allowances.

If $\alpha_1 < 1,\ \alpha_3 < 1,\ \alpha_2 > 0,$

(12) $$\alpha_4 + \alpha_5 \log A + \alpha_6 (\log A)^2 + \alpha_7 CU6 + \alpha_8 CO6 > 0,$$

and α_9 is positive, or if negative, sufficiently small numerically, then $\log v(C,h)$ is increasing in C, decreasing in (h) for fixed C and strictly concave in (C,h). The parameters of the utility function, together with the coefficients present in the job-availability indicator b_j and in the density of offered hours $g_j(h)$, are estimated by maximum likelihood.

[6] As of December 2005 1 USD is approximately equal to NOK 6.80

3. Data and estimates

3.1 Data

Data on the labor supply of married women in Norway used in this study consists of a merged sample from "Survey of Income and Wealth, 1994", Statistics Norway (1994) and "Level of living conditions, 1995", Statistics Norway (1995). Data covers married couples as well as cohabiting couples with common children. The age of the spouses ranges from 25 to 64. None of the spouses are self-employed and none of them are on disability or other type of benefits. All taxes paid are observed and in the assessment of disposable income, at hours not observed, all details of the tax system are accounted for. Hours of work are related to main job as well as possible side jobs. In 1994 the unemployment rate was rather low by international standard. Thus, for that reason it may be of little importance to employ desired hours (which we don't have) instead of actual hours. The size of the sample used in estimating the labor supply model is 810.

Wage rates above NOK 350 or below NOK 40 are not utilized when estimating the wage equations. The wage rates are computed as the ratio of annual wage income to hours worked. When computing annual wage income we take into account that some women have multiple jobs. Description of variables and summary statistics are given in Appendix A and the tax function and child allowances are given in Appendix B.

3.2. Estimates of labor supply probabilities and hours of work

In Table 1 we give the estimates of the structural labor supply model. The estimated coefficients imply that the deterministic part of the utility function is quasi-concave. The interaction term between consumption and leisure is negative and significantly different from zero, which means that separability between consumption and leisure is rejected. Marginal utilities with respect to consumption and leisure are positive. Marginal utility of leisure declines with age to around 32 years of age and thereafter it increases with age. The number of young and "old" children has a similar and positive effect on the marginal utility of leisure. Thus, when the woman is young and has children she has a reduced incentive to take part in work outside the home and when the children have grown up she gradually again gets a weakened incentive to participate in the labor market because of becoming older.

The estimates of the opportunity densities imply:

- for the higher educated women there are more jobs available in the public than in the private sector
- the full-time peak is more distinct in the public than in the private sector

Table 2 compares observed and predicted aggregates outcomes and we note that the model predicts these observed aggregates pretty well. The model predicts that 8.3 percent of the married women are not working. The predicted split between the public and the private sector is almost equal, with slightly more married women working in the public sector than in the private. Hours worked, conditional on working, is predicted to

be almost the same across sectors, with a few more hours predicted for the private sector than for the public.

Table 1. Estimation results for the parameters of the labor supply probabilities.

	Uniformly distributed offered hours, but with part-time and fulltime peaks		
Variables	Parameters	Estimate	t-values
Preferences:			
Consumption:			
Exponent	α_1	0.64	7.6
Scale 10^{-4}	α_2	1.77	4.2
Subsistence level C_0 in NOK per year		60 000	
Leisure:			
Exponent	α_3	-0.53	-2.1
Constant	α_4	115.02	3.2
Log age	α_5	-63.61	-3.2
(log age)^2	α_6	9.20	3.3
# children 0-6	α_7	1.27	4.0
# children 7-17	α_8	0.97	4.1
Consumption and Leisure, interaction	α_9	-0.12	-2.7
Subsistence level of leisure in hours per year		5120	
The parameters b_1 and b_2; $\log b_j = f_{j1} + f_{j2}S$			
Constant, public sector (sector 1)	f_{11}	-4.20	-4.7
Constant, private sector (sector 2)	f_{21}	1.14	1.0
Education, public sector (sector 1)	f_{12}	0.22	2.9
Education, private sector (sector 2)	f_{22}	-0.34	-3.3
Opportunity density of Offered hours, $g_{k2}(h)$, k=1,2			
Full-time peak, public sector (sector 1)*	$\log\left(g_1(h_{Full})/g_1(h_0)\right)$	1.58	11.8
Full-time peak, private sector (sector 2)	$\log\left(g_2(h_{Full})/g_2(h_0)\right)$	1.06	7.4
Part-time peak, public Sector	$\log\left(g_1(h_{Part})/g_1(h_0)\right)$	0.68	4.4
Part-time peak, private Sector	$\log\left(g_2(h_{Part})/g_2(h_0)\right)$	0.80	5.2
# observations		810	
Log likelihood		-1760.9	

* The notation h_0 refers to an arbitrary level of hours of work different from full-time and part-time hours.

Table 2. Observed and predicted aggregates, married women, Norway 1994

Variables	Not working		Public sector		Private sector	
	Observed	Predicted	Observed	Predicted	Observed	Predicted
Choice probabilities	0.080	0.083	0.492	0.470	0.428	0.447
Annual hours	0	0	1641	1567	1570	1606
McFadden's ρ^2	0.211					
McFadden's adjusted ρ^2	0.195					

Table 3 reports how the predicted choice probabilities vary with socio-economic characteristics. The probability of *not working* is decreasing with age and education, sharply increasing with the number of children and they are also increasing rather strongly with non-labor income. The older the woman and the lower her education level is, the more likely it is that she works in the private sector.

The probability of working in the public sector is remarkable similar across number of children and deciles in the distribution of non-labor income. In contrast, the choice probability in the private sector declines rather strongly with number of children and deciles in the distribution of non-labor income. These findings accord well with wide-held conjectures that child-care facilities are more easily available in the public sector than in the private. They also accord with the "observations" that for the highly educated women, who tend to be married to educated and well-paid men, there are more interesting and challenging jobs in the public than in the private sector. This is also supported by the predictions in Table 3, where we observe that participation in the public sector is increasing rather sharply with the years of education of the woman.

Table 4 gives the predictions of the conditional expectations of hours and its variation with socio-economic characteristics. Expected hours, given working, are predicted to vary little across ages. They drop sharply in both sectors when the households get 2 or more children. Expected hours, given working, are also considerably lower in the upper deciles relative to in the lower deciles.

Of particular interest is the prediction of how hours vary with education in the two sectors. In the public sector hours increases slightly with years of education, while in the private sector the highly educated woman is predicted to work rather long hours. As mentioned above highly educated women tend to prefer the public rather than the private sector, but those who start working in the private sector work long hours. Although our estimates indicate that human capital are higher priced out at the margin in the public sector we should keep in mind that hours are less regulated in the private sector and wage dispersion is higher. Examples of well paid women working long hours in the private sector are women in leading management positions and female doctors working in private clinics rather in public hospitals. The question is whether improvements in job opportunities like higher wages, lower taxes and less regulated hours will move more women with high education from the public sector to the private sector. These are some of the issues that we discuss in the next sections.

Table 3. Choice probabilities and their variation with socio-economic variables, married women, Norway 1994. Percent.

Variables	Not working	Public sector	Private sector
Age range:			
25-34	10.45	47.32	42.33
35-44	7.75	49.05	43.20
43-64	6.80	44.71	48.49
Number of children:			
0	4.89	46.02	49.09
1	6.18	48.88	44.94
2	10.09	46.76	43.15
More than 2	16.79	47.03	36.18
Education:			
Low, ≤9 years	9.71	27.54	62.74
Intermediate	9.05	43.42	47.52
High, 15-17 years	4.42	73.27	22.31
Non-labor income:			
1decile	2.89	45.40	51.71
2-9 deciles	8.04	47.03	44.92
10 decile	15.29	48.71	36.00

Table 4. Conditional expectations of annual hours and their variation with socio-economic variables, married women, Norway 1994.

Variables	Public sector	Private sector
Age range:		
25-34	1530	1576
35-44	1571	1631
43-64	1598	1608
Number of children:		
0	1689	1694
1	1627	1662
2	1490	1530
More than 2	1310	1363
Eduaction:		
Low, ≤9 years	1535	1531
Intermediate	1552	1604
High, 15-17 years	1607	1768
Non-labor income:		
1decile	1690	1706
2-9 deciles	1567	1602
10 decile	1457	1502

4. Wage elasticities, inter- and intra sectoral elasticities

In Tables 5-7 we give the wage elasticities in labor supply among married women when the hourly wage rates are increased. The choice probabilities in (7) and (8) are used to calculate these elasticities. Note that in order to do so one has to make draws before and after the wage rate change (2500 for each female each time) from the joint distribution of η_1 and η_2. The elasticities are calculated for each individual and thereafter aggregated, and we term the elasticities aggregate elasticities. These elasticities are the mean of individual elasticities, which of course is different from the elasticities of the mean of labor supply.

Overall wage increase and overall labor supply

The first column of Table 5 defines the categories that the elasticities are calculated for. We have calculated the elasticities for all and according to deciles in the distribution of hourly wage rates and disposable income. The second column gives the elasticities of the probabilities of working at all and working in the public and the private sector. For short we term these elasticities the working sector probability. The next column gives the elasticities of hours of work, given that the individual works either in the public or the private sector. The last column is (approximately) equal to the sum of the two preceding columns and gives the elasticities of the unconditional expectation of labor supply with respect to wage rate changes.

In the interpretation of wage elasticities there are several factors one should keep in mind. A higher wage gives the individual a stronger incentive to participate in the labor force and to work longer hours, given participation. However those with the strongest incentive to work long hours, typically women with a high return on their human capital may also have interesting and challenging jobs to such an extent that a wage increase may have a minor impact on their labor supply. Because of the matching process in the marriage market, women with high education tend to be married to men with high education and consequently high earnings. This may create an income effect, which may reduce the labor supply of these women. Women with a low potential wage, married to a man with full-time earnings, also may have an incentive to work few hours.

The sector dimension introduced here may play a role in how an increased wage may affect behavior. In the public sector human capital variables are better priced out, which makes the public sector more attractive for women with a higher education. On the other hand hours are more regulated and the wage level and wage dispersion is less than in the private sector. A wage increase may then give the woman working in the public sector an incentive to move to the private sector. A typical example is a nurse or a medical doctor working in a public hospital who starts working in a private clinic.

When turning to the simulated values of the elasticities we first note that an overall wage increase reduces the probability of *not working*, and more so in the lower deciles in the distribution of household disposable income. The elasticities are sizeable but we should keep in mind that the probabilities of not working are rather low, on average around 8 percent (see Table 2).

The next block of results reported in Table 5 says that an overall wage increase implies an elasticity with respect to working (in any sector) of 0.26. The elasticity of hours supplied, conditional on working, is slightly higher, 0.32, which means that the

aggregate elasticity of labor supply in the population of married females in Norway in 1994 sums up to around 0.59.

Next we report how these elasticities vary with the deciles in the wage distribution (before the wage rate change). Women with higher potential wage rates seem to be less responsive in their labor market participation decision than women with lower potential wage rates. The same pattern occurs when we calculate the elasticities of hours supplied, given participation in any sector, with the exception that differences are smaller.

Taking into account the responses in labor market participation, as well as in hours of work, given participation, we observe that the aggregate elasticity of labor supply in the total population of married females with respect to an overall wage increase is declining with the deciles in the wage distribution. Women belonging to the lowest deciles in the wage distribution are estimated to have a labor supply elasticity of 0.70, with an almost equal split on participation and hours of work (given participation), while women at the top of the wage distribution has a labor supply elasticity of 0.46. Clearly, women with the highest potential wage, most likely with more interesting jobs than women with lower wages, and working longer hours (Table 4), are less responsive in their labor supply than women with lower potential wage.

The next lines in Table 5 give the same elasticities, but now according to the deciles in the distribution of disposable household income. Now the labor market participation responses are slightly reversed. Women in the lower deciles of the distribution of disposable household income tend to be less responsive than women belonging to higher deciles. Elasticities of hours of work, conditional on participation, are nearly the same across the deciles in the distribution of disposable household income. Most likely these results are due to the interaction of income effects in labor supply and the matching process in the marriage market. Women married to men with high incomes work lesser hours than women married to men with lower incomes. When wages are increased more labor supply can be generated through increased participation and longer hours among women married to men with high incomes.

Overall wage increase and sectoral responses

Turning now to the choice of sector and sector specific supply of hours, we observe that in the public sector the wage elasticities are declining with the deciles in the wage distribution, and they are approximately constant across deciles in the distribution of disposable household income. The negative sign of the elasticities of the public sector choice probability with respect to an overall wage increase for women in the upper deciles in the wage distribution (-0.10) indicates that women with the highest potential wage may have some incentive to shift from working in the public sector to work in the private sector. The high elasticity of private sector choice probability (0.88) in the upper deciles supports this hypothesis.

In the private sector we observe that the elasticity of the choice probability is increasing with the deciles in the wage distribution as well as in the distribution of disposable household income distribution. As mentioned above education and experience is slightly higher priced out in the public than in the private sector, which means that women with higher education and more experience should be expected to favor the public sector rather than the private. But also as demonstrated above the wage level and dispersion of wages, captured by the variance in the distribution of the random variables that affects wages, are higher in the private than in the public sector. Moreover, offered

hours tend to be more uniformly distributed in the private sector than in the public. All of these factors mentioned here are represented in the model. Higher chances to find jobs with longer working hours and higher wage levels may be the reason why women with the highest potential wage would like to shift their labor supply from the public to the private sector, and to find jobs with longer working hours, when there is an overall wage increase.

We also report the elasticity of tax revenue with respect to an overall wage increase. Tax revenues are increased for two reasons. A higher wage yields higher earnings, given labor supply. A higher wage stimulates labor supply. We observe that the elasticity is estimated to be 0.69, which is clearly less than 1.

Wage increase in the public sector only

In Table 6 we report the wage elasticities when only the wage in the public sector is increased. Comparing Tables 5 and 6 we observe that the impacts on overall labor supply is considerably weaker when the wage rate in the public sector only is increased. The pattern with respect to variation in wage elasticities across deciles in the distribution of wages and disposable income is similar to the pattern when wages in both sectors were increased. The most important result is that the modest wage elasticities related to work in any sector (overall labor supply) shadow for much higher inter-sector wage elasticities. A wage increase in the public sector gives the women an incentive to shift labor from the private to the public sector. Hours of work, given the sector, are only modestly affected.

Wage increase in the private sector only

The same pattern emerges when the wage in the private sector only is increased, Table 7. As discussed above, but even more here, we get that the wage elasticities related to participation in the public sector are declining with the deciles in the distribution of hourly wages and disposable household income, while the opposite occurs in the private sector. We note that women with the highest wage rates have a strong incentive to shift jobs from the public to the private as a response to a wage increase in the private sector.

Table 5. Aggregate elasticities of labor supply wrt an overall wage increase in the public and the private sector. Married Norwegian females, 1994.

	Mean Working Sector Probability	*Mean conditional expected hours*	*Mean unconditional expected hours*
NOT WORKING	-3,11		
Deciles on Disp. Income:			
1	-3,50		
2-9	-3,19		
10	-2,64		
ALL (Private and Public)	0,26	0,32	0,59
Deciles on hourly wages:			
1	0,34	0,36	0,70
2-9	0,26	0,32	0,59
10	0,15	0,31	0,46
Deciles on Disp. Income:			
1	0,21	0,34	0,55
2-9	0,25	0,32	0,59
10	0,32	0,31	0,64
PUBLIC	0,09	0,37	0,46
Deciles on hourly wages:			
1	0,20	0,45	0,66
2-9	0,11	0,37	0,49
10	-0,10	0,32	0,22
Deciles on Disp. Income:			
1	0,07	0,38	0,44
2-9	0,09	0,37	0,46
10	0,10	0,35	0,45
PRIVATE	0,48	0,34	0,84
Deciles on hourly wages:			
1	0,53	0,37	0,92
2-9	0,45	0,33	0,80
10	0,88	0,31	1,22
Deciles on Disp. Income:			
1	0,35	0,34	0,70
2-9	0,47	0,34	0,82
10	0,83	0,37	1,22
Total tax revenue			0.69

Table 6. Aggregate elasticities of labor supply wrt a wage increase in the public sector. Married Norwegian females, 1994.

	Mean Working Sector Probability	*Mean conditional expected hours*	*Mean unconditional expected hours*
NOT WORKING	-1.71		
Deciles on Disp. Income:			
1	-1.92		
2-9	-1.75		
10	-1.47		
ALL (Private and Public)	0.14	0.17	0.33
Deciles on hourly wages:			
1	0.15	0.16	0.34
2-9	0.15	0.17	0.34
10	0.10	0.23	0.34
Deciles on Disp. Income:			
1	0.11	0.15	0.28
2-9	0.14	0.17	0.33
10	0.19	0.17	0.38
PUBLIC	1.52	0.33	1.90
Deciles on hourly wages:			
1	1.96	0.41	2.45
2-9	1.63	0.34	2.02
10	0.81	0.30	1.13
Deciles on Disp. Income:			
1	1.80	0.33	2.18
2-9	1.55	0.33	1.93
10	1.16	0.32	1.52
PRIVATE	-1.29	0.03	-1.26
Deciles on hourly wages:			
1	-1.08	0.03	-1.05
2-9	-1.27	0.04	-1.24
10	-2.00	0.06	-1.94
Deciles on Disp. Income:			
1	-1.23	0.03	-1.20
2-9	-1.29	0.03	-1.26
10	-1.36	0.00	-1.36
Total tax revenue			0.28

Table 7. Aggregate elasticities of labor supply wrt a wage increase in the private sector. Married Norwegian females, 1994.

	Mean Working Sector Probability	*Mean conditional expected hours*	*Mean unconditional expected hours*
NOT WORKING	-1.78		
Deciles on Disp. Income:			
1	-2.08		
2-9	-1.84		
10	-1.44		
ALL (Private and Public)	0.15	0.15	0.32
Deciles on hourly wages:			
1	0.23	0.19	0.44
2-9	0.15	0.15	0.32
10	0.06	0.08	0.16
Deciles on Disp. Income:			
1	0.13	0.18	0.33
2-9	0.15	0.15	0.32
10	0.16	0.13	0.32
PUBLIC	-1.40	0.04	-1.37
Deciles on hourly wages:			
1	-1.63	0.03	-1.60
2-9	-1.46	0.03	-1.44
10	-1.01	0.03	-0.98
Deciles on Disp. Income:			
1	-1.65	0.05	-1.61
2-9	-1.42	0.03	-1.39
10	-1.09	0.04	-1.05
PRIVATE	1.81	0.31	2.17
Deciles on hourly wages:			
1	1.60	0.34	2.00
2-9	1.74	0.30	2.09
10	3.20	0.24	3.52
Deciles on Disp. Income:			
1	1.56	0.31	1.92
2-9	1.80	0.30	2.15
10	2.33	0.36	2.77
Total tax revenue			0.49

5. The impact on labor supply of constraints on offered hours.

In the model $b_j g_j(h)$ represent the combination of available jobs and the density of offered hours. As mentioned above the density of offered hours have two peaks, one at part-time work and one at full-time work. The alternative is to assume that offered hours are uniformly distributed, which is the standard assumption in neoclassical labor supply model. To illustrate the role of this latter assumption we have used the model to simulate the impacts on labor supply of replacing our estimated density function, with spikes at part time and full time hours, with uniformly distributed offered hours.

When constrained offered hours, with probability mass at part-time work and full-time work is replaced by uniformly distributed offered hours, we must adjust the b_j-s to ensure that the amount of available jobs in the economy remains the same. This is done by adjusting the constant f_{j1} for j=1,2 in equation (9) above. Let f_{j1}^* denote the adjusted constant for sector j in equation (9) above and let b_j^* denote the corresponding new value for b_j. Let γ_{jF} and γ_{jP} denote the parameters associated with full- time and part-time hours in sector j. It can be shown that the new values of b_j and f_{j1} are given by:

$$\log b_j^* = f_{j1}^* + f_{j2}S \tag{13}$$

and

$$f_{j1}^* = f_{j1} + \log\left[\frac{5 + \exp(\gamma_{jF}) + \exp(\gamma_{jP})}{7}\right] \tag{14}$$

for j=1,2. Note that we have 7 categories of hours of which two are part-time and full-time work loads. With the estimates in Table 1 (γ_{1F}=1.58, γ_{1P}= 0.68, γ_{2F}= 1.06, γ_{2P}=0.8, f_{11}=-4.20 and f_{21}=1.14) we get that the new constants have to increase to –3.68 ($=f_{11}^*$, sector 1, the public sector) and to 1.51 ($=f_{21}^*$, sector 2, the private sector). Because more jobs are concentrated around full-time hours in the public sector than in the private sector, the increase in the b_j for the public sector has to be the largest.

The impacts on the choice probabilities are negligible. The probability of not working is 0.083 when hours are constrained and 0.086 when offered hours are uniform. The difference between the choice probabilities of working in the public and private sectors, respectively, is of the same negligible order.

Of greater interest is the impact on hours worked (Table 8) and wage elasticities (Table 9). Table 8 shows that replacing the current constraints on offered hours with uniformly distributed hours have a *negative* effect on annual hours supplied, conditional on working, and more so in the public sector than in the private. The reduction in overall labor supply amounts to 6.3 percent.

Because the spikes play a more important role in the public than in the private sector we should expect that labor supply are more affected in the public sector by removing the constraint on hours. Removing the constraint on offered hours makes it more likely that a woman find jobs with fewer hours than full time hours, in particular when working in the public sector. It depends on preferences and on the non-labor income whether labor supply will increase or decrease. But for many women say, with

children and with a husband in a full job, fewer hours than implied by a full time job may be preferred.

Table 8. Mean expected annual hours, conditional on working. Married women, Norway 1994. Constrained hours versus uniform hours when the amount of available jobs are kept the same.

Categories	Constrained offered hours	Uniform offered hours
Working in any sector		
All	1586	1487
1 deciles*	1600	1488
2-9 deciles	1598	1502
10 deciles	1476	1363
Working in public sector		
All	1567	1407
1 deciles	1559	1388
2-9 deciles	1570	1412
10 deciles	1551	1390
Working in the private sector		
All	1606	1571
1 deciles	1554	1500
2-9 deciles	1615	1583
10 deciles	1584	1562

*Deciles are deciles in the distribution of disposable household income, 1994

Table 9 gives the wage elasticities, conditional on working and we see that with uniformly distributed offered hours labor supply become more responsive, in particular among those working in the public sector. The reason for the former result is that with uniform offered hours labor supply is lower and hence more responsive, and the reason for the latter results is that hours are more constrained in the public sector than in the private and hence a removal of these constraints will make labor supply more responsive.

Table 9. Aggregate elasticites of labor supply with respect to an overall wage

Categories	Constrained offered hours	Uniform offered hours
Working in any sector		
All	0.32	0.42
1 deciles*	0.34	0.43
2-9 deciles	0.32	0.42
10 deciles	0.31	0.41
Working in public sector		
All	0.37	0.50
1 deciles	0.38	0.51
2-9 deciles	0.37	0.50
10 deciles	0.35	0.50
Working in the private sector		
All	0.34	0.41
1 deciles	0.34	0.41
2-9 deciles	0.34	0.41
10 deciles	0.37	0.45

*Deciles are deciles in the distribution of disposable household income, 1994

6. Tax reforms

In 1992 the Norwegian tax system was reformed towards lower and less progressive tax rates. In the next following years the tax structure was kept nearly unchanged. To assess the impacts on labor supply we have therefore chosen to focus on the pre-tax-reform year 1991 and post-reform year 1994.

The tax rates on labor incomes in 1991 and 1994 are set out in Appendix B, and we observe that the reform of 1992 reduced the top marginal tax rate from 0.654 to 0.495, which is a considerable reduction. To assess the labor supply responses to this reform we have employed our model to simulate the labor supply among married women. Because the 1992 reform was a reform towards less progressive taxes, we have also used the model to simulate the impact on labor supply of replacing the 1994 tax system with a revenue neutral flat tax. The results are set out in Table 10. Note that when taxes are changed they are also changed on the wage income of the spouse.

When the 1991 tax regime is replaced by the 1994 tax regime we get the following labor supply responses:

- an increase in labor market participation from 88.2 percent to 91.8 percent,
- the increase in participation is almost the same across the deciles in the distribution of disposable household income (in 1994),
- there is a slight reduction in public sector participation,
- there is a considerable increase in participation in the private sector,
- the expected hours of work, given participation in any sector, increase by around 200 hours a year, mostly in the upper deciles in the distribution of disposable household income, the increase in expected working hours is particular large for women working in the private sector,

- despite the fact that labor supply is stimulated by the reform, tax revenue goes down. The reason is that lower tax rates outweigh the effect on tax revenue from the increase in labor supply.

Accounting for labor supply responses a flat tax of 29 percent on all income is found to yield the same tax revenue as the 1994 tax system. By introducing a flat tax system the labor supply responses from the tax reform in 1992 is reinforced. There is no change in overall participation, but there is a further shift in participation away from the public sector towards the private sector. Working hours are predicted to increase further, in particular in the upper deciles and in the private sector. But it should be noted that there is also a rather strong increase in supply of labor in the lowest deciles, in particular in the public sector.

In Table 11 we report how choice probabilities vary with socio-economic characteristics. We note that the flat tax reinforces the labor supply effects of the 1992 tax reform, with the exception that overall market participation in upper income deciles with a flat tax is even lower than prior to the 1992 tax reform. The reasons are most likely the following: The tax reform of 1992 is predicted to yield a much higher participation among women belonging to the richest households (1991 compared to 1994). With a flat tax reform the marginal tax rates as well as the average tax rate is reduced for high incomes relative to the 1991 taxes. The 1992 tax reform lower the marginal tax rates, but the average tax rates paid by the households is not reduced that much. Thus, these two reforms gives rise to different combinations of substitution and income effects in the participation decision, with stronger income effects for the richest households when a flat tax is introduced. We also note that women with the highest education level are more likely to choose the private sector after the 1992 tax reform, and much more so after the flat tax reform.

Table 12 reports the mean of expected hours, conditional on working in the public or the private sector and grouped according to socio-economic characteristics The most notable results is the large increase in hours worked in the private sector among women with the highest education level as a response to the tax reforms. With a flat tax the increase is more than 400 annual hours.

Table 10. Labor supply responses to the tax reform of 1992 and to a flat tax of 0.29.

	Mean working probabilities, percent			Mean Conditional expected annual hours			Mean Unconditional expected annual hours		
	1991	1994	Flat tax	1991	1994	Flat tax	1991	1994	Flat tax
Not working	11.8	8.3	8.2						
In deciles:									
1	5.9	4.5	5.6						
2-9	11.6	8.0	7.2						
10	18.5	13.9	18.3						
All sectors (public and private)	88.2	91.8	92.0	1460	1586	1703	1288	1455	1562
In deciles:									
1	92.2	94.3	94.0	1508	1600	1707	1330	1468	1567
2-9	88.5	92.1	92.7	1470	1598	1725	1297	1467	1584
10	82.4	86.6	82.5	1333	1476	1521	1176	1354	1396
Public sector	47.5	47.0	44.4	1472	1567	1647	700	737	731
In deciles:									
1	42.7	41.8	39.8	1479	1559	1636	631	652	651
2-9	47.2	46.8	44.4	1475	1570	1650	697	735	734
10	54.7	54.3	48.5	1445	1551	1637	790	842	794
Private sector	40.7	44.7	47.4	1444	1606	1754	588	718	831
In deciles:									
1	49.5	52.5	54.2	1414	1554	1689	699	816	916
2-9	41.3	45.3	48.3	1454	1615	1762	600	732	850
10	27.7	32.3	34.0	1395	1584	1772	386	512	602
Tax revenue, Mill 1994 NOK							130	113	113

Remarks:

1) Deciles were defined on the basis of 1994 disposable income, and kept constant through the different simulations performed.
2) Note that only the overall probabilities of the following sectors: Not working, working in Public and working in Private, are expected to sum up to 100.

Table 11 . Choice probabilities and their variation with socio-economic variables. Percent.

Variable	1991			1994			Flat tax 29%		
	Not working	Public sector	Private sector	Not working	Public sector	Private sector	Not working	Public sector	Private sector
Age range:									
25-34	14.43	47.56	38.01	10.45	47.32	42.23	10.12	45.06	44.82
35-44	11.19	49.71	39.10	7.75	49.05	43.20	7.24	46.32	46.43
43-64	9.90	45.27	44.83	6.80	44.71	48.49	7.44	41.79	50.77
Number of children									
0	7.31	47.27	45.42	4.89	46.02	49.09	5.55	42.92	51.53
1	9.11	50.03	40.86	6.18	48.88	44.94	5.39	46.42	48.20
2	14.39	46.62	38.99	10.09	46.76	43.15	9.71	44.39	45.90
more than 2	22.37	45.71	31.92	16.79	47.03	36.18	16.75	44.67	38.57
Woman education									
low (?9 years)	13.37	26.54	60.09	9.71	27.54	62.74	8.90	27.48	63.62
Intermediate (10-13years)	12.82	43.46	43.72	9.05	43.42	47.52	9.24	41.19	49.57
High (15-17 years)	6.84	76.41	16.75	4.42	73.27	22.31	3.98	67.37	28.65
Non-labor income									
1decile	4.16	47.37	48.48	2.89	45.40	51.71	2.50	42.95	54.55
2-9 deciles	11.64	47.47	40.89	8.04	47.03	44.92	7.10	44.87	48.03
10 decile	20.12	48.15	31.72	15.29	48.71	36.00	22.51	42.01	35.48

Table 12. Conditional expected annual hours in different tax rate system by several variables and ranges.

Variable	1994		1991		Flat tax 29%	
	Public sector	Private sector	Public sector	Private sector	Public sector	Private sector
Age range:						
25-34	1530	1576	1465	1434	1589	1706
35-44	1571	1631	1470	1462	1656	1785
43-64	1598	1608	1481	1438	1695	1764
Number of children						
0	1689	1694	1587	1528	1775	1843
1	1627	1662	1533	1496	1699	1806
2	1490	1530	1393	1369	1569	1677
more than 2	1310	1363	1215	1215	1399	1523
Woman education						
low (≤9 years)	1535	1531	1455	1406	1605	1642
Intermediate (10-13years)	1552	1604	1464	1446	1628	1747
High (15-17 years)	1607	1768	1494	1531	1702	1968
Non- labour income:						
1decile	1690	1706	1595	1542	1771	1849
2-9 deciles	1567	1602	1471	1441	1646	1749
10 decile	1457	1502	1363	1340	1540	1669

7. Compensating variation within a random utility model

To evaluate further the tax reform of 1992, we will calculate the change in household welfare. To do so we employ a recent method suggested by Dagsvik and Karlstrøm (2005). The calculation of Compensating Variation, CV, is not straightforward in a random utility model when utility is not linear in household income. A random utility function implies that the expenditure function is also random. What we do is to calculate the expected value of CV, E[CV], for each individual and thereafter we calculate the mean and spread in the population.

From (1) we get the following implicit definition of the CV when the tax regime of 1991 is compared to the tax regime of 1994:

$$(15)\quad U(C,h,\varepsilon(z)\,|\,\text{Tax regime}\,1991) = U(C-CV,h,\varepsilon(z)\,|\,\text{Tax regime}\,1994)$$

In equation (1) we have suppressed the subscript of the individual and we should also keep in mind that the choice of each individual is to choose to work or not, and given work, to choose sector and hours of work, given the job opportunity sets and the budget constraints under the different tax regimes and CV. In the calculation of the expected value of CV we take of course this choice structure into account. If an individual benefits from the tax reform, the expected value of CV for this individual is positive, meaning that this amount has to be subtracted from household income under the 1994 tax regime in order to make the individual indifferent between the two tax regimes. Below we will report the mean and spread of the expected value of CV. To proceed with the calculation we need some notation.

Note first that the deterministic part of the utility function can be written $v_i=v(C(h_i),h_i|X)$, where i denotes the jobs, 1,2,,,15. When i=1 the individual is not working and i=2,3,,8 denote jobs in the public sector, while i=9,,,15 denote jobs in the private sector. C is household consumption, which equals the sum of the after-tax labor income of husband and wife plus the after tax capital income and public transfer like child allowances. X is a vector of all exogenous characteristics entering the model.

Now let

$$(16)\quad v_i^0 = v(C(h_i\,|\,\text{Tax regime}\,1991), h_i\,|\,X)$$

and let

$$(17)\quad v_i^*(y) \equiv v(C^*(h_i,y), h_i\,|\,X)$$

where $C^*(h_i,y) = F(h_i) + y$, $F(h_i)=w_ih_i-T(w_ih_i)$ and T(.) is the tax function for 1994.

Let E[CV] be the expected value of the compensating variation, which can be calculated for each individual as follows (Dagsvik and Karlstrøm (2005)):

$$(18)\quad E[CV] = I^* - \sum_i^{15}\left[v_i^0 g_i b_i \int_0^{\tilde{y}_i} \frac{dy}{\sum_{i=1}^{15} \max[(v_i^0 g_i b_i),(v_i^*(y) g_i b_i)]} \right]$$

where according to Table 1 above:

$g_i = 1$ for all i except for $i = 4,6,11,13$

$g_4 = \exp(0.68)$

$g_6 = \exp(1.58)$

$g_{11} = \exp(0.80)$

$g_{13} = \exp(1.06)$

$b_1 = 1$

$b_i = \exp(-4.20 + 0.22X_4)$; for $i = 2,3,,8$

$b_i = \exp(1.14 - 0.33X_4)$; for $i = 9,10,,,15$.

and

$\tilde{y}_i$ is given by the following equation:

$$(19) \quad v_i^0 = v_i^*(\tilde{y}_i)$$

I* equals the sum of the after tax income of husband earnings and capital income, plus child allowances. The estimate of E(CV) is given in Table 13.

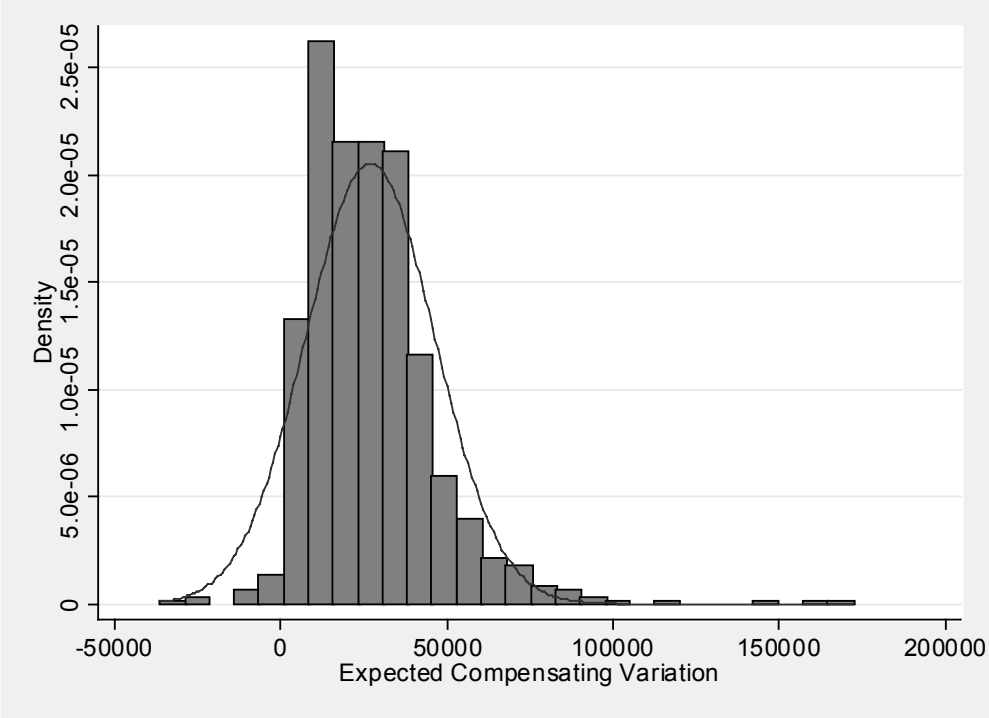
We should keep in mind that tax revenues are not kept constant, see Table 10 above. On average the households used in the sample gets around NOK 17 000 in tax cuts. Thus the tax reform is a combination of a change of the tax structure and reduction in tax revenues.

Table 13. Expected value of compensating variation, an estimate of the welfare changes for households of the 1992 tax reform. NOK 1994, 1991 tax system used as reference against 1994 tax system.

	E(CV)
All	27098
Deciles in the distribution of household disposable income, 1994:	
decile 1 (poor)	7248
deciles 2-9 (middle)	24622
decile 10 (rich)	66242

From Table 13 we observe that from the tax reform of 1992 the mean of the household in the sample gained NOK 27098. The richest household gained almost ten times more than the poorest. The distribution of expected gain across households is given in Figure 1, and we observe that most of the households will benefit from the 1992 tax reform. Thus, the reform would have got a clear majority support at elections, which it actually also got.

Figure 1 . Histogram of Expected Compensating Variation. Distribution of E(CV), 1991 tax regime against the 1994 tax regime.

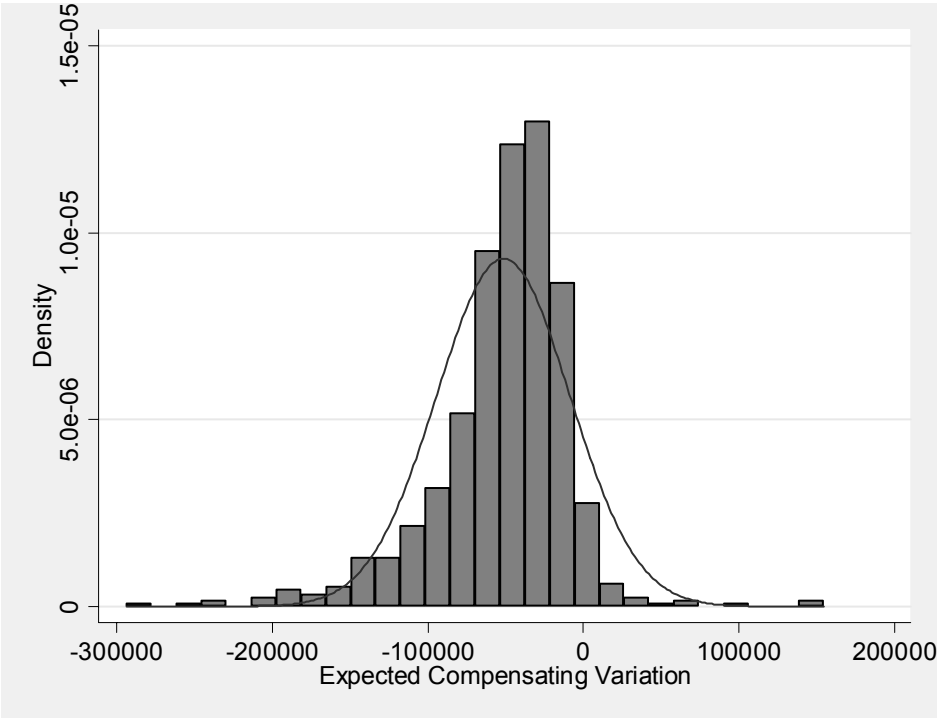


We have also calculated the expected value of compensating variation of a flat tax reform. In the calculations the tax-revenue neutral flat tax reform of 29% is used as a reference. Negative values mean that the numerical values have to be added to household incomes under the 1994 tax regime in order to make the households indifferent in welfare terms between the 1994 regime and the flat tax regime. Table 14 then says that on average the households will lose NOK 51528 of not having the flat tax relative to the 1994 tax regime. The richest households lose around 4 times more than the poorest. Thus, in a distributional sense the richest household benefited far more from having the 1991 regime replaced by the 1994 tax regime than what they might have gained from having the latter regime replaced by a flat tax. In Figure 2 we show the distribution of expected values of the compensating variations across households and we observe that a vast majority will benefit from having the 1994 tax regime replaced by a flat tax.

Table 14. Expected value of compensating variation, an estimate of the welfare changes for households of a flat tax reform. NOK 1994, a flat tax regime used as reference against the 1994 regime.

	E(CV)
All	-51528
Deciles in the distribution of household disposable income, 1994:	
decile 1 (poor)	-21360
deciles 2-9 (middle)	-51342
decile 10 (rich)	-82796

Figure 2 . Histogram of Expected Compensating Variation. Distribution of E(CV) the flat tax system of 29% as reference against the 1994 tax regime.



8. Conclusions

A female labor supplied model, estimated on data from Norway, 1994 has been used in simulation to yield wage elasticities. The overall elasticities are rather small, but these small elasticities shadow for much stronger sectoral responses. We find that the elasticity

of labor supply with respect to the wage rate is much lower among the women with the highest market wage rate than for those with lowest.

In the model we have specified two sectors, public and private, and we find that a wage increase, overall and by sectors, has a strong positive impact on sector choice probabilities. A wage increase gives the women an incentive to shift labor supply from the public to the private sector. This is particular true for women belonging to the highest deciles in the distribution of wage rates and even more so in the distribution of disposable household income. This pattern occurs despite the fact that education and experiences have a slightly higher return in the public than in the private sector. The reasons for our result are that the wage level and the wage dispersion are higher in the private than in the public sector. Moreover, offered hours of work are less regulated in the private sector compared to in the public.

The Norwegian tax reform of 1992 implied a considerable reduction in the top marginal tax rate, but the tax rates in lower brackets were also reduced. We find that the impact on overall labor supply is rather modest, but again these modest changes shadow for stronger sectoral changes. The tax reform stimulated the women to shift their labor from the public to the private sector and to work longer hours. The latter was particular true for women belonging in the upper deciles of the income distribution and working in the private sector. Despite the fact that labor supply was stimulated the tax reform implied a reduction in tax revenue. Thus, the lower tax rates implied lower tax revenues when labor supply responses were accounted for. A calculation of the expected value of changes in household welfare demonstrated that the richest households benefited far more from the tax reform than the poorest household.

A flat tax reform, with the same tax revenue as in 1994, reinforces the labor supply responses of the 1992 reform. In relative terms the richest households benefit more from the 1992 tax reform than from a having a further reform towards a flat tax.

An obvious extension of the model is to extend the analysis to deal with transitions across sectors over time and to estimate this dynamic model on panel data from the 1990s.

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Appendix A. Description of variables and summary statistics

Table A.1. Description of the variables used in the analysis **(values in NOK, 1994)**

Symbols	Description	
FNR	Identification number	
FAR	Woman Year of birth	
B02	Number of children 0-2	
B36	Number of children 3-6	
B717	Number of children 7-17	
B06	Number of children 0-6	
MALDER	Age in year (man)	
MUTD	Education in year (man)	
KALDER	Age in year (woman)	
KUTD	Education in year (woman)	
INR	Choice variable of working hours: 1-15	
ARBTID		
	Annual hours of work as follows:	
	INR =1 ARBTID = 0;	
	Public sector	**Private sector**
	INR =2 ARBTID = 315.1763;	INR =9 ARBTID = 315.1763;
	INR =3 ARBTID = 780;	INR =10 ARBTID = 780;
	INR =4 ARBTID = 1040;	INR =11 ARBTID = 1040;
	INR =5 ARBTID = 1560;	INR =12 ARBTID = 1560;
	INR =6 ARBTID = 1976;	INR =13 ARBTID = 1976;
	INR =7 ARBTID = 2340;	INR =14 ARBTID = 2340;
	INR =8 ARBTID = 2600;	INR =15 ARBTID = 2600;
KAPINNT	Household capital income	
MANNLONN	Men wage income per year	
Variable generated:		
KUTD_100	Woman Education in year (KUTD) /100	
SKILL	Work Experience = woman age–woman education in year (KUTD) – six (starting school age)	
SK_100	SKILL/100	
SK2_100	$(SKILL/100)^2$	
CAPINC	Net capital income (CAPINC)=KAPINNT–CHALL as KAPINNT includes CHALL. CHALL is child allowances, see Appendix B	
W_PU	Woman hourly wage in public sector	
W_PR	Woman hourly wage in private sector	

Table A.2. Descriptive statistics, number of observations = 810.

Variable	Mean	Std. Dev.	Min	Max
FAR	53.92	9.04	30.00	69.00
B02	0.23	0.45	0.00	2.00
B36	0.30	0.56	0.00	3.00
B717	0.66	0.85	0.00	4.00
MALDER	42.80	9.17	25.00	66.00
MUTD	12.05	2.49	9.00	19.00
KALDER	40.07	9.04	25.00	64.00
LNKALDER	3.66	0.22	3.22	4.16
KUTD	11.61	2.15	9.00	17.00
INR	7.83	4.01	1.00	15.00
B06	0.54	0.77	0.00	3.00
ARBTID	1482.89	664.97	0.00	2600.00
SEKTOR	1.34	0.61	0.00	2.00
KUTD_100	0.11	0.02	0.09	0.17
SKILL	22.45	9.63	2.00	49.00
SK_100	0.22	0.09	0.02	0.49
SK2_100	0.05	0.04	0.0004	0.24
KAPINNT	32306.71	42378.48	0.00	568403.00
CHALL	13094.37	12154.01	0.00	60084.00
KVLONN	149751.97	83060.53	0.00	581693.00
MANNLONN	274372.89	106239.67	17312.00	1184861.00
W_PU	89.36	12.09	64.88	132.34
W_PR	109.77	13.68	80.14	156.44

Appendix B Tax functions and child allowances.

Tax function in 1994 for a married non-working woman, husband is working. NOK 1994.

Mannlonn, Y_{male}	**Tax T**
0-41907	0
41907-140500	$0.302Y_{male}$-12656
140500-252000	$0.358Y_{male}$-20524
252000-263000	$0.453Y_{male}$-44464
263000-	$0.495Y_{male}$-55510

Tax function in 1994 for a married working woman, or working man. NOK 1994.

Wage income, Y	**Tax ,T**
0-20954	0
20954-140500	0.302Y-6328
140500-208000	0.358Y-14196
208000-236500	0.453Y-33956
236500-	0.495Y-43889

In 1994 the child allowances were:

One child between 0 and 17: NOK 10416
Two children between 0 and 17:NOK 21336
Three children between 0 and 17: NOK 33696
Four children between 0 and 17: NOK 46692
Five children or more between 0 and 17:NOK 60084

Tax function in 1991 for a married non-working woman, husband is working. NOK 1994.

Mannlonn,Y_{male}	**Tax T**
0-38392	0
38392-70746	$0.303Y_{male}$-11642
70746-171915	$0.343Y_{male}$-14455
171915-200567	$0.418Y_{male}$-27348
200567-264239	$0.558Y_{male}$-55428
264239-	$0.654Y_{male}$-80509

Tax function in 1991 for a married working woman, or working man. NOK 1994.

Wage income Y	**Tax T**
0-19596	0
19596-22639	0.343Y-6722
22639-70746	0.303Y-5832
70746-137956	0.343Y-8634
137956-174037	0.418Y-18981
174037-219669	0.558Y-42964
219669-	0.654Y-64214

Appendix C. Wage equations

Wage equations accounting for hetereogeneity, with η_j denoting the random effect are:

$w_{1i} = w^*_{1i}\eta_{1i} = \exp(\alpha_0 + \alpha_1 Z_{1i} + \alpha_2 Z_{2i} + \alpha_3 Z_{3i} + \sigma_1(\log\eta_{1i}))$, for the public sector

$w_{2i} = w^*_{2i}\eta_{2i} = \exp(\alpha_0 + \alpha_1 Z_{1i} + \alpha_2 Z_{2i} + \alpha_3 Z_3 + \sigma_2(\log\eta_{2i}))$, for the private sector

where Z_i are, respectively, woman experience (divided by 100), the square of the previous variable, and woman education in years (divided by 100), and η_j the random effect on wages.

Estimates of wage equations. Norwegian women 1994

Variables	Public sector		Private sector	
	Estimates	t-values	Estimates	t-values
Constant	3.37	13.5	3.70	25.2
Experience in years/100	3.21	6.0	2.55	5.1
(Experience in years/100)^2	-4.75	-5.3	-3.80	-4.2
Education in years/100	5.57	4.9	5.26	4.2
Log (Probability of working in the chosen sector)	-0.12	-2.0	0.06	0.9
Variances	0.059	18.6	0.075	17.0
No of observations	691		580	
R^2	0.14		0.08	

Appendix D. Wage Elasticities under 1991 tax regime and under a flat tax.

Table D.1 Wage elasticities under the 1991 tax system. Overall wage changes

	Mean Working Sector Probability	*Mean conditional expected hours*	*Mean unconditional expected hours*
NOT WORKING	-2.69		
Deciles on Disp. Income:			
1	-3.08		
2-9	-2.75		
10	-2.26		
ALL (Private and Public)	0.32	0.18	0.50
Deciles on hourly wages:			
1	0.42	0.21	0.64
2-9	0.32	0.18	0.50
10	0.19	0.18	0.37
Deciles on Disp. Income:			
1	0.26	0.19	0.46
2-9	0.32	0.18	0.50
10	0.36	0.18	0.54
PUBLIC	0.25	0.22	0.48
Deciles on hourly wages:			
1	0.41	0.32	0.75
2-9	0.27	0.22	0.50
10	0.07	0.17	0.24
Deciles on Disp. Income:			
1	0.20	0.25	0.45
2-9	0.25	0.22	0.48
10	0.27	0.21	0.48
PRIVATE	0.49	0.18	0.68
Deciles on hourly wages:			
1	0.58	0.20	0.80
2-9	0.46	0.17	0.64
10	0.71	0.26	0.98
Deciles on Disp. Income:			
1	0.36	0.18	0.54
2-9	0.48	0.18	0.67
10	0.77	0.23	1.01
Total tax revenue			0.61

Table D.2 Wage elasticities under the 1991 tax system. Change in public wage.

	Mean Working Sector Probability	*Mean conditional expected hours*	*Mean unconditional expected hours*
NOT WORKING	-1.51		
Deciles on Disp. Income:			
1	-1.71		
2-9	-1.54		
10	-1.30		
ALL (Private and Public)	0.18	0.10	0.29
Deciles on hourly wages:			
1	0.20	0.10	0.32
2-9	0.18	0.10	0.29
10	0.14	0.13	0.28
Deciles on Disp. Income:			
1	0.13	0.09	0.24
2-9	0.18	0.10	0.29
10	0.23	0.10	0.34
PUBLIC	1.40	0.21	1.64
Deciles on hourly wages:			
1	1.91	0.30	2.28
2-9	1.51	0.21	1.75
10	0.68	0.17	0.86
Deciles on Disp. Income:			
1	1.64	0.22	1.90
2-9	1.43	0.21	1.67
10	1.06	0.19	1.27
PRIVATE	-1.20	0.00	-1.20
Deciles on hourly wages:			
1	-1.01	0.00	-1.01
2-9	-1.18	0.01	-1.18
10	-2.02	0.03	-2.00
Deciles on Disp. Income:			
1	-1.15	0.00	-1.15
2-9	-1.20	0.01	-1.20
10	-1.27	-0.02	-1.28
Total tax revenue			0.28

Table D.3 Wage elasticities under the 1991 tax system. Changes in the private wage.

	Mean Working Sector Probability	*Mean conditional expected hours*	*Mean unconditional expected hours*
NOT WORKING	-1.47		
Deciles on Disp. Income:			
1	-1.76		
2-9	-1.52		
10	-1.17		
ALL (Private and Public)	0.17	0.08	0.26
Deciles on hourly wages:			
1	0.27	0.10	0.39
2-9	0.17	0.08	0.26
10	0.06	0.04	0.12
Deciles on Disp. Income:			
1	0.16	0.10	0.27
2-9	0.18	0.08	0.26
10	0.17	0.08	0.26
PUBLIC	-1.13	0.01	-1.12
Deciles on hourly wages:			
1	-1.39	0.02	-1.37
2-9	-1.20	0.01	-1.19
10	-0.69	0.01	-0.68
Deciles on Disp. Income:			
1	-1.39	0.03	-1.36
2-9	-1.15	0.01	-1.14
10	-0.81	0.02	-0.79
PRIVATE	1.74	0.18	1.95
Deciles on hourly wages:			
1	1.61	0.20	1.84
2-9	1.68	0.17	1.88
10	3.13	0.21	3.41
Deciles on Disp. Income:			
1	1.52	0.18	1.72
2-9	1.74	0.17	1.94
10	2.20	0.24	2.49
Total tax revenue			0.39

Table D.4 Wage elasticities under a flat tax (29%) and revenue neutral system. Overall wage change

	Mean Working Sector Probability	*Mean conditional expected hours*	*Mean unconditional expected hours*
NOT WORKING	-3.17		
Deciles on Disp. Income:			
1	-3.16		
2-9	-3.45		
10	-2.31		
ALL (Private and Public)	0.26	0.41	0.68
Deciles on hourly wages:			
1	0.33	0.44	0.79
2-9	0.26	0.41	0.69
10	0.15	0.37	0.53
Deciles on Disp. Income:			
1	0.22	0.41	0.64
2-9	0.25	0.41	0.67
10	0.38	0.37	0.76
PUBLIC	-0.03	0.46	0.43
Deciles on hourly wages:			
1	0.10	0.52	0.62
2-9	0.00	0.46	0.46
10	-0.25	0.42	0.15
Deciles on Disp. Income:			
1	-0.01	0.44	0.43
2-9	-0.04	0.46	0.42
10	0.02	0.45	0.47
PRIVATE	0.58	0.43	1.03
Deciles on hourly wages:			
1	0.58	0.49	1.10
2-9	0.54	0.43	1.00
10	1.01	0.30	1.34
Deciles on Disp. Income:			
1	0.41	0.44	0.87
2-9	0.55	0.43	1.01
10	1.10	0.43	1.58
Total tax revenue			0.62

Table D.5 Wage elasticities under a flat tax (29%) and revenue neutral system. Public wage change

	Mean Working Sector Probability	*Mean conditional expected hours*	*Mean unconditional expected hours*
NOT WORKING	-1.70		
Deciles on Disp. Income:			
1	-1.71		
2-9	-1.85		
10	-1.21		
ALL (Private and Public)	0.14	0.20	0.37
Deciles on hourly wages:			
1	0.14	0.19	0.36
2-9	0.14	0.21	0.38
10	0.09	0.27	0.38
Deciles on Disp. Income:			
1	0.11	0.18	0.32
2-9	0.13	0.21	0.37
10	0.21	0.20	0.44
PUBLIC	1.70	0.40	2.17
Deciles on hourly wages:			
1	2.07	0.47	2.64
2-9	1.79	0.41	2.28
10	1.03	0.37	1.43
Deciles on Disp. Income:			
1	1.99	0.38	2.44
2-9	1.71	0.40	2.18
10	1.37	0.40	1.83
PRIVATE	-1.30	0.06	-1.25
Deciles on hourly wages:			
1	-1.10	0.05	-1.06
2-9	-1.28	0.07	-1.22
10	-1.84	0.08	-1.77
Deciles on Disp. Income:			
1	-1.25	0.06	-1.20
2-9	-1.30	0.06	-1.25
10	-1.33	0.02	-1.31
Total tax revenue			0.24

Table D.6 Wage elasticities under a flat tax (29%) and revenue neutral system. Private wage change

	Mean Working Sector Probability	*Mean conditional expected hours*	*Mean unconditional expected hours*
NOT WORKING	-1.89		
Deciles on Disp. Income:			
1	-1.92		
2-9	-2.06		
10	-1.33		
ALL (Private and Public)	0.15	0.20	0.39
Deciles on hourly wages:			
1	0.24	0.24	0.52
2-9	0.15	0.20	0.39
10	0.07	0.11	0.19
Deciles on Disp. Income:			
1	0.13	0.23	0.39
2-9	0.15	0.20	0.38
10	0.21	0.16	0.40
PUBLIC	-1.67	0.05	-1.62
Deciles on hourly wages:			
1	-1.81	0.04	-1.77
2-9	-1.71	0.05	-1.67
10	-1.37	0.05	-1.32
Deciles on Disp. Income:			
1	-1.88	0.06	-1.84
2-9	-1.69	0.05	-1.64
10	-1.35	0.05	-1.31
PRIVATE	1.89	0.38	2.33
Deciles on hourly wages:			
1	1.67	0.44	2.18
2-9	1.82	0.37	2.26
10	3.07	0.22	3.36
Deciles on Disp. Income:			
1	1.63	0.38	2.07
2-9	1.86	0.37	2.30
10	2.55	0.40	3.05
Total tax revenue			0.46

Appendix E. Wage elasticities by socio-economic characteristics.

Table E1 . Elasticities of choice probabilities wrt wages. 1994 tax regime.

Variable	Overall wage increase			Public wage increase			Private wage increase		
	Not working	Public sector	Private sector	Not working	Public sector	Private sector	Not working	Public sector	Private sector
Age range:									
25-34	-2,94	0,10	0,61	-1,60	1,47	-1,25	-1,68	-1,34	1,92
35-44	-3,17	0,08	0,48	-1,83	1,47	-1,35	-1,74	-1,37	1,87
43-64	-3,27	0,08	0,38	-1,74	1,64	-1,26	-1,96	-1,50	1,66
Number of children									
0	-3,45	0,02	0,33	-1,84	1,60	-1,32	-2,08	-1,54	1,65
1	-3,40	0,02	0,45	-1,89	1,48	-1,35	-1,97	-1,44	1,84
2	-3,13	0,14	0,58	-1,73	1,53	-1,25	-1,78	-1,35	1,88
more than 2	-3,13	0,14	0,58	-1,73	1,53	-1,25	-1,78	-1,35	1,88
Woman education									
low (≤9 years)	-3,00	0,36	0,31	-1,26	2,58	-0,94	-2,09	-1,95	1,18
Intermediate (10-13years)	-3,08	0,14	0,46	-1,68	1,74	-1,27	-1,79	-1,54	1,75
High (15-17 years)	-3,49	-0,09	0,97	-2,66	0,79	-2,06	-1,25	-0,97	3,42
Non-labour income:									
1decile	-3,89	-0,03	0,24	-2,12	1,72	-1,39	-2,37	-1,70	1,62
2-9 deciles	-3,21	0,09	0,48	-1,76	1,53	-1,28	-1,85	-1,41	1,80
10 decile	-2,55	0,20	0,81	-1,43	1,32	-1,18	-1,38	-1,10	2,08

Table E2. Elasticities of choice probabilities wrt wages. 1991 tax regime.

Variable	**Overall wage increase**			**Public wage increase**			**Private wage increase**		
	Not working	Public sector	Private sector	Not working	Public sector	Private sector	Not working	Public sector	Private sector
Age range:									
25-34	-2,56	0,29	0,60	-1,43	1,38	-1,19	-1,39	-1,07	1,87
35-44	-2,72	0,24	0,47	-1,60	1,35	-1,26	-1,41	-1,10	1,80
43-64	-2,83	0,22	0,41	-1,52	1,48	-1,16	-1,64	-1,22	1,60
Number of children									
0	-3,00	0,15	0,33	-1,62	1,43	-1,23	-1,75	-1,25	1,58
1	-2,96	0,19	0,43	-1,69	1,35	-1,28	-1,62	-1,15	1,77
2	-2,68	0,32	0,60	-1,52	1,44	-1,16	-1,46	-1,08	1,83
more than 2	-2,68	0,32	0,60	-1,52	1,44	-1,16	-1,46	-1,08	1,83
Woman education									
low (≤9 years)	-2,64	0,45	0,39	-1,07	2,44	-0,84	-1,85	-1,75	1,19
Intermediate (10-13years)	-2,66	0,30	0,48	-1,47	1,64	-1,20	-1,49	-1,29	1,72
High (15-17 years)	-2,97	0,10	0,76	-2,39	0,68	-2,11	-0,86	-0,65	3,33
Non-labour income:									
1decile	-3,42	0,08	0,21	-1,87	1,52	-1,33	-2,02	-1,41	1,55
2-9 deciles	-2,77	0,25	0,50	-1,55	1,41	-1,20	-1,53	-1,13	1,75
10 decile	-2,18	0,38	0,80	-1,26	1,24	-1,08	-1,11	-0,85	1,99

Table E3 Elasticities of probabilities wrt wages. Flat tax, 29%.

Variable	**Overall wage increase**			**Public wage increase**			**Private wage increase**		
	Not working	Public sector	Private sector	Not working	Public sector	Private sector	Not working	Public sector	Private sector
Age range:									
25-34	-3,03	-0,03	0,72	-1,59	1,60	-1,25	-1,81	-1,58	2,00
35-44	-3,45	-0,05	0,58	-1,93	1,65	-1,35	-1,97	-1,65	1,95
43-64	-3,07	-0,01	0,45	-1,59	1,85	-1,29	-1,89	-1,77	1,73
Number of children									
0	-3,09	-0,09	0,41	-1,60	1,81	-1,33	-1,92	-1,81	1,72
1	-3,66	-0,13	0,53	-1,99	1,63	-1,35	-2,20	-1,71	1,90
2	-3,29	0,03	0,67	-1,78	1,69	-1,26	-1,94	-1,60	1,96
more than 2	-3,29	0,03	0,67	-1,78	1,69	-1,26	-1,94	-1,60	1,96
Woman education									
low (≤9 years)	-3,22	0,33	0,31	-1,36	2,73	-0,99	-2,24	-2,09	1,22
Intermediate (10-13years)	-3,08	0,03	0,55	-1,63	1,90	-1,28	-1,85	-1,77	1,82
High (15-17 years)	-3,90	-0,27	1,17	-2,79	0,97	-1,89	-1,66	-1,32	3,33
Non- labour income:									
1decile	-4,31	-0,14	0,31	-2,36	1,92	-1,40	-2,68	-1,97	1,67
2-9 deciles	-3,52	-0,04	0,56	-1,89	1,69	-1,30	-2,11	-1,67	1,87
10 decile	-2,18	0,21	1,14	-1,14	1,58	-1,15	-1,25	-1,33	2,37

Table E4. Elasticities of conditional expected hours wrt wage, 1994

Variable	**Overall wage change**		**Publi wage change**		**Private wage change**	
	Public sector	Private sector	Public sector	Private sector	Public sector	Private sector
Age range:						
25-34	0,40	0,35	0,35	0,02	0,04	0,32
35-44	0,36	0,33	0,33	0,04	0,03	0,29
43-64	0,34	0,34	0,30	0,04	0,04	0,31
Number of children						
0	0,30	0,31	0,25	0,03	0,046	0,28
1	0,35	0,33	0,30	0,04	0,049	0,30
2	0,44	0,39	0,39	0,04	0,053	0,35
more than 2	0,52	0,44	0,47	0,03	0,047	0,41
Woman education						
low (≤9 years)	0,39	0,36	0,36	0,04	0,028	0,326
Intermediate (10-13years)	0,38	0,33	0,34	0,04	0,031	0,290
High (15-17 years)	0,34	0,29	0,31	0,06	0,026	0,224
Non-labour income:						
1decile	0,30	0,30	0,26	0,04	0,05	0,26
2-9 deciles	0,37	0,34	0,33	0,03	0,04	0,31
10 decile	0,41	0,38	0,38	0,01	0,03	0,37

Table E5. Elasticities of conditional expected hours wrt wages, 1991 tax regime.

Variable	**Overall wage change**		**Public wage change**		**Private wage change**	
	Public sector	Private sector	Public sector	Private sector	Public sector	Private sector
Age range:						
25-34	0,26	0,18	0,24	-0,009	0,03	0,19
35-44	0,21	0,17	0,21	0,008	0,002	0,16
43-64	0,20	0,19	0,18	0,009	0,01	0,17
Number of children						
0	0,18	0,17	0,16	0,004	0,02	0,17
1	0,23	0,19	0,20	0,01	0,03	0,18
2	0,28	0,22	0,26	0,02	0,03	0,20
more than 2	0,32	0,24	0,30	0,01	0,02	0,23
Woman education						
low (≤9 years)	0,25	0,19	0,24	0,01	0,006	0,18
Intermediate (10-13years)	0,23	0,17	0,22	0,01	0,009	0,16
High (15-17 years)	0,20	0,21	0,19	0,02	0,009	0,18
Non-labour income:						
1decile	0,19	0,16	0,17	0,010	0,03	0,15
2-9 deciles	0,23	0,19	0,21	0,006	0,02	0,18
10 decile	0,24	0,22	0,23	-0,013	0,01	0,22

Table E6. Elasticities of conditional expected hours wrt wages. Flat tax rate = 29%

Variable	**Overall wage changes**		**Public wage changes**		**Private wage changes**	
	Public sector	Private sector	Public sector	Private sector	Public sector	Private sector
Age range:						
25-34	0.48	0.45	0.42	0.05	0.054	0.40
35-44	0.46	0.42	0.40	0.06	0.047	0.36
43-64	0.43	0.44	0.37	0.06	0.065	0.38
Number of children						
0	0.37	0.40	0.31	0.06	0.065	0.34
1	0.43	0.42	0.37	0.06	0.065	0.36
2	0.53	0.49	0.46	0.07	0.072	0.42
more than 2	0.65	0.57	0.58	0.05	0.066	0.52
Woman education						
low (?9 years)	0.48	0.49	0.43	0.07	0.05	0.42
Intermediate (10-13years)	0.47	0.43	0.41	0.07	0.05	0.36
High (15-17 years)	0.44	0.30	0.39	0.08	0.04	0.22
Not labour income:						
1decile	0.36	0.38	0.30	0.07	0.06	0.31
2-9 deciles	0.46	0.44	0.40	0.06	0.06	0.38
10 decile	0.52	0.49	0.47	0.03	0.04	0.46

Table E7. Elasticities of unconditional expected hours wrt wages, 1994.

Variable	**Overall wage increase**		**Public wage increase**		**Private wage increase**	
	Public sector	Private sector	Public sector	Private sector	Public sector	Private sector
Age range:						
25-34	0.50	0.98	1.87	-1.23	-1.30	2.30
35-44	0.44	0.82	1.86	-1.32	-1.35	2.22
43-64	0.43	0.74	1.99	-1.23	-1.46	2.02
Number of children						
0	0.31	0.65	1.89	-1.29	-1.50	1.98
1	0.37	0.79	1.83	-1.32	-1.40	2.19
2	0.59	0.99	1.98	-1.21	-1.30	2.29
more than 2	0.81	1.35	1.94	-1.12	-1.06	2.60
Woman education						
low (?9 years)	0.77	0.68	3.03	-0.90	-1.93	1.54
Intermediate (10-13years)	0.52	0.81	2.15	-1.24	-1.52	2.09
High (15-17 years)	0.25	1.29	1.13	-2.01	-0.94	3.72
Not labour income:						
1decile	0.27	0.55	2.02	-1.36	-1.66	1.93
2-9 deciles	0.46	0.85	1.91	-1.25	-1.37	2.17
10 decile	0.62	1.22	1.74	-1.17	-1.08	2.53

Table E8. Elasticities of unconditional expected hours wrt wages, 1991 tax regime.

Variable	**Overall wage increase**		**Public wage increase**		**Private wage increase**	
	Public sector	Private sector	Public sector	Private sector	Public sector	Private sector
Age range:						
25-34	0.56	0.80	1.65	-1.20	-1.05	2.09
35-44	0.45	0.66	1.59	-1.25	-1.10	1.99
43-64	0.42	0.60	1.70	-1.15	-1.21	1.80
Number of children						
0	0.33	0.50	1.61	-1.23	-1.23	1.78
1	0.42	0.63	1.58	-1.27	-1.13	1.98
2	0.61	0.83	1.73	-1.15	-1.06	2.07
more than 2	0.81	1.16	1.69	-1.03	-0.84	2.32
Woman education						
low (?9 years)	0.71	0.59	2.74	-0.83	-1.75	1.39
Intermediate (10-13years)	0.54	0.66	1.90	-1.19	-1.28	1.91
High (15-17 years)	0.30	0.98	0.88	-2.09	-0.65	3.57
Not labour income:						
1decile	0.27	0.38	1.71	-1.32	-1.39	1.73
2-9 deciles	0.48	0.69	1.65	-1.19	-1.12	1.96
10 decile	0.64	1.03	1.50	-1.09	-0.84	2.25

Table E9. Elasticities of unconditional expected hours wrt wages. Flat tax rate 29%. by several variables and ranges

Variable	**Overall wage change**		**Public wage change**		**Private wage change**	
	Public sector	Private sector	Public sector	Private sector	Public sector	Private sector
Age range:						
25-34	0.44	1.20	2.09	-1.20	-1.54	2.48
35-44	0.41	1.03	2.13	-1.29	-1.61	2.38
43-64	0.43	0.91	2.29	-1.24	-1.72	2.18
Number of children						
0	0.28	0.82	2.17	-1.28	-1.76	2.12
1	0.30	0.97	2.06	-1.29	-1.66	2.32
2	0.56	1.20	2.23	-1.20	-1.54	2.47
more than 2	0.84	1.65	2.24	-1.12	-1.29	2.90
Woman education						
low (?9 years)	0.83	0.81	3.27	-0.93	-2.06	1.69
Intermediate (10-13years)	0.50	1.00	2.40	-1.22	-1.73	2.25
High (15-17 years)	0.16	1.50	1.40	-1.82	-1.28	3.63
Not labour income:						
1decile	0.21	0.70	2.28	-1.34	-1.92	2.04
2-9 deciles	0.42	1.03	2.16	-1.25	-1.62	2.32
10 decile	0.74	1.68	2.13	-1.12	-1.29	2.93