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LABOR SUPPLY, INCOME DISTRIBUTION AND EXCESS BURDEN OF PERSONAL INCOME TAXATION IN SWEDEN

by

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ABSTRACT

The paper presents results from a labor supply study on Swedish data. The estimated labor supply model is based on a new methodological approach. This approach is well suited for taking into account complex non-linear and non-convex budget constraints, unobservable institutional constraints on hours as well as joint labor supply decisions of married couples. The model is estimated on Swedish data from 1981. The resulting wage elasticities of total labor supply turn out to be numerically small.

The model is used to simulate the effects on labor supply, income distribution and costs of taxation from replacing the 1981 tax system by a system with proportional and lump-sum taxes. The impact on labor supply is shown to be substantial despite the fact that wage elasticites are small.

1. INTRODUCTION

This paper presents the results of en empirical analysis of labor supply in Sweden based on a new modeling approach. This approach was introduced by Dagsvik and Strøm (1990) and employed on Norwegian data. The motivation behind the development of the new approach is that we wish to take into account complicated non-convex budget sets. The Hausman type approach (see Hausman, 1980) is in general intractable in this case since it has only proved practical for simple labor supply functions (mostly linear) and simple non-convex budget constraint.

There are several features of our model that distinguishes it from previous empirical labor supply models with taxes. First, as mentioned above, it is designed to deal with non-linear labor supply functions and complicated non-convex budget sets for two-person households. Second, it accounts for latent restrictions on hours. Regulations by law, wage-hours contracts in unionized economies and demand constraints restrict the hours decisions of the individual. These restrictions are reflected in the observed frequencies of hours worked with a typical two-peak distribution for females (full time/part time) and a one-peak distribution for males. Most likely, these concentrations are due to restrictions on the choice set of hours of work.

Third, the model is an household model in the sense that the optimal decisions of hours worked by the husband and the wife is assumed to follow from the maximization of a joint utility function. Thus, the possible endogeneity bias introduced by the assumption of an exogeneously given income of the spouse is avoided.

Previous labor supply studies in Sweden are Axelsson et al. (1981), Gustafsson and Jacobsson (1983) and Blomquist (1983, 1988, 1989). In Axelsson et al. hours are analysed, but taxes are not explicitly accounted for. Gustafsson and Jacobsson analyze female participation, also without taxes. Blomquist (1988) applies the Hausman approach with linear labor supply function. In Blomquist (1989) a quadratic deterministic supply function is applied which represents a very strong a priori restriction. No restriction on hours are specified in these models and the income of the spouse is taken as given when the male (Blomquist, 1983 and 1988) and the female (Blomquist, 1988) labor supply is estimated. The latter can introduce an endogeneity bias, see Blundell and Meghir (1984).

A brief, but self-contained, description of the model is given in

Sections 2 and 3. Section 4 deals with the data and Section 5 with the estimation results. In Section 6 we report the results of various policy simulations in order to demonstrate how taxes affect behavior.

2. THE MODEL

For expository simplicity we consentrate on one person households in the present section. The individual is assumed to choose from a set of "packages" called matches. A match is defined as a particular combination of skills offered (by the individual) and qualifications required to perform specific tasks. The individual is assumed to maximize his utility with respect to matches given his opportunities and budget constraints. We assume that the individual has perfect knowledge about his opportunities, but due to unobserved heterogeneity across individuals the set of feasible matches is viewed as random by the econometrician.

Let z=1,2,..., be an enumeration of the matches. Match z is characterized by fixed hours of work, H(z), wage rate, W(z), qualifications demanded, $T_2(z)$, and skills offered, $T_3(z)$. For non-market matches, $H(z)=W(z)=T_2(z)=T_3(z)=0$.

The individual's economic budget constraint, conditional on match z, is given by

$$(2.1) \quad C = C(z) \equiv f(H(z)W(z)+I)$$

where C is consumption, I is nonlabor income and $f(\cdot)$ is the function that transforms gross income to income after tax. The form of the function f depends on the tax system and of the rules of social security payments, etc. It may be non-differentiable, non-concave, even discontinuous. Let

$$(2.2) \quad T_1(z) = \theta(T_2(z),T_3(z))$$

where $\theta(\cdot)$ is a "distance" function in the sense that it attains low value to matches where the difference between skills offered and demanded is large.

The individual's utility function is assumed to have the form

$$(2.3) \quad U(C,h,z) = v(C,h,T_1(z)) + \varepsilon(z)$$

where $v(C,h,t)$ is a deterministic function that is quasi-concave in (h,C), decreasing in h and increasing in C for fixed t. $\varepsilon(z)$ is a random variable that is supposed to account for unobserved heterogeneity in tastes. Moreover, the utility function is supposed to depend on how well the individual is fit for the match measured through $T_1(z)$.

As mentioned above the collection of matches feasible to the individual is random to the econometrician and consequently the set of feasible attributes and tasteshifters, $\{H(z),W(z),T(z),\varepsilon(z)\}$, where $T(z)=(T_1(z), T_2(z))$ is random. Specifically, we assume that $\{H(z),W(z),T(z),\varepsilon(z)\}$ are the points of a Poisson process on $[0,\bar{h}]x[0,\bar{w}]x[0,1]^2xR$ with intensity measure

(2.4a) $\lambda(h,w,t_1,t_2)dhdwdt_1dt_2 \cdot e^{-\varepsilon}d\varepsilon$

for market matches and

(2.4b) $\lambda(0,0,0,0)e^{-\varepsilon}d\varepsilon$

when $h=w=t_1=t_2=0$. Eq. (2.4a) means that the probability that a match for which

$$(H(z)\in(h,h+dh),W(z)\in(w,w+dw),T(z)\in(t,t+dt),\varepsilon(z)\in(\varepsilon,\varepsilon+d\varepsilon),\ t=(t_1,t_2)$$

is feasible, is equal to

$$\lambda(h,w,t_1,t_2)dhdwdt_1dt_2 \cdot e^{-\varepsilon}d\varepsilon + o(dhdwdt_1dt_2d\varepsilon).$$

We assume that

(2.5a) $\lambda(h,w,t_1,t_2) = \mu g_1 g_2(h) g_3(w|t_2) g_4(t_1) g_5(t_2)$

and

(2.5b) $\lambda(0,0,0,0) = \mu(1-g_1)$

where $\mu>0$ is a constant, $g_1\in[0,1]$, $g_2(h)$, $g_3(w|t_2)$, $g_4(t_1)$ and $g_5(t_2)$ are probability densities. As demonstrated in Dagsvik and Strøm (1990), $g_2(h)$

and $g_3(w|t_2)$ can be interpreted as the densities of feasible hours and wages (given required qualifications) offered by the firms, while $g_4(t_1)$ and $g_5(t_2)$ are the densities of distance and qualifications, respectively. The interpretation of g_1 is as the fraction of feasible matches that are market matches. The particular decomposition (2.5a) means that offered hours and wages are independent. Offered hours are independent of $\{T(z)\}$ and wages are independent of $\{T_1(z)\}$. These assumptions are justified as follows: Offered hours of work are often determined by the nature of the tasks to be performed and by institutional regulations independent of wages and individual and firm-specific characteristics. The assumption that $g_3(w|t_2)$ does not depend on t_1 may be more difficult to defend since one may claim that offered wages may depend on how well the individual is fit for the job. However, if we let $g_3(w|t_2)$ also depend on t_1 we run into serious identification problems. Anyhow we believe that the main wage determinants are the qualifications represented by $\{T_2(z)\}$. Note, however, that there still can be dependence between realized hours and wages as a result of choices made by the individuals.

Let us now consider the realized hours and wage distribution in the market. Let $\varphi(h,w)$ be the probability density of the realized hours of work and wages i.e., the hours-wage combination that correspond to the match that yields the highest utility. According to Dagsvik (1988) the Poisson process assumption and (2.4) imply that

$$(2.6a)\quad \varphi(h,w) = \frac{\iint e^{\psi(h,w,t_1)}\lambda(h,w,t_1,t_2)dt_1dt_2}{\iiiint e^{\psi(x,y,t_1)}\lambda(x,y,t_1,t_2)dxdydt_1dt_2+e^{\psi(0,0,0)}\lambda(0,0,0,0)}$$

for $h>0$, $w>0$, $t_1>0$, $t_2>0$ and

$$(2.6b)\quad \varphi(0,0) = \frac{e^{\psi(0,0,0)}\lambda(0,0,0,0)}{\iiiint e^{\psi(x,y,t_1)}\lambda(x,y,t_1,t_2)dxdydt_1dt_2+e^{\psi(0,0,0)}\lambda(0,0,0,0)}$$

where

$$(2.7)\quad \psi(h,w,t_1) = v(f(hw+I),h,t_1).$$

The probability density (2.6) of realized hours and wages depends on the preferences as well as on the choice opportunities. This is not in accordance with the conditions of perfect equilibrium, which require that the (empirical) distribution of realized hours and wages coincides with the (empirical) distribution of preferred hours and wages. To assume that every realization equals equilibrium values is rather restrictive since it excludes the possibility of minor market imperfections and noise affecting realized hours and wages. A less restrictive assumption is to assume equality between the theoretical distributions of preferred and realized hours and wages. This means that the corresponding empirical distributions will not necessarily coincide in small samples. In Dagsvik and Strøm op.cit. this latter equilibrium concept is denoted quasi-equilibrium (QE). QE implies that hours, wages and skills adjust so that the probability density of realized hours and wages depend solely on the preference terms.

In the real world there are, however, more severe imperfections. Examples are institutional restrictions imposed by unions and government on hours and wages. These restrictions prevent the equilibrating process, even of the "large sample" type alluded to above, to take place. Hence, a model of labor supply should allow for a possible deviation between the distributions of realized and preferred hours and wages. In our model we do this by postulating a partial QE. By this we understand that wages adjust so as to give QE within groups of matches. A group is identified by a specific level of $(H(z),T(z))$. We thus assume that the conditional distribution of realized wages, given hours and attributes $\{T(z)\}$, depends solely on preferences. This implies that the wage rate must be a function of individual qualifications. It can then be shown that under partial QE (2.6) implies that

$$(2.8) \quad W(z) = \tilde{w}(T_2(z))$$

where $\tilde{w}(\cdot)$ is a function that satisfies

$$(2.9) \quad g_3(\tilde{w}(t_2)|t_2) = 1/\bar{w}.$$

Thus if (2.8) holds the density of offered wages conditional on qualifications (as measured by $T_2(z)$) is uniform.

From (2.8) and (2.9) it follows that the unconditional wage density across qualification groups take the form

$$(2.10)\quad \tilde{g}(w) = g_5(\tilde{t}_2(w))\left|\frac{d\tilde{t}_2(w)}{dw}\right|$$

where $\tilde{t}_2(\cdot)$ is the inverse mapping of $\tilde{w}(\cdot)$. By inserting (2.10) into (2.6) we get the realized hours and wage density under partial QE;

$$(2.11a)\quad \tilde{\varphi}(h,w) = \frac{g_1 \exp(\tilde{\psi}(h,w))g_2(h)\tilde{g}(w)}{g_1\int\int \exp(\tilde{\psi}(x,y))g_2(x)\tilde{g}(y)dxdy+\kappa(1-g_1)\exp(\tilde{\psi}(0,0))}$$

for $h>0$, $w>0$ and

$$(2.11b)\quad \tilde{\varphi}(0,0) = \frac{\kappa(1-g_1)\exp(\tilde{\psi}(0,0))}{g_1\int\int \exp(\tilde{\psi}(x,y))g_2(x)\tilde{g}(y)dxdy+\kappa(1-g_1)\exp(\tilde{\psi}(0,0))}$$

where

$$(2.12)\quad \tilde{\psi}(h,w) = \log(\int \exp(\psi(h,w,t_1))g_4(t_1)dt_1)$$

and

$$(2.13)\quad \kappa = \frac{e^{v(C,0,0)}}{\int e^{v(C,0,t_1)}g_4(t_1)dt_1}.$$

The interpretation of κ is as a parameter that accounts for the value of non-market matches relative to the value of the market matches evaluated at $h=0$. In general κ may depend on C (evaluated at $h=0$), but in the empirical specification made below κ reduces to a constant.

Note that g_1 and $g_2(h)$ in (2.11) accounts for the possible market imperfections associated with job availability ("unemployment") and offered hours in partial QE.

3. EXTENSION OF THE MODEL TO TWO-PERSON HOUSEHOLDS (MARRIED COUPLES)

The decision problem of a married couple is to determine jointly the labor supply of the wife and of the husband as well as the level of consumption of the household, subject to the budget and hours constraints.

Let $U(C,h_F,h_M,z)$ denote the household's utility function where h_F and h_M denote the wife's and the husband's hours of work, respectively. C is total consumption of the household and $z = (z_F,z_M)$ indexes the matches of the wife, z_F, and husband, z_M, respectively.

The constraints are given by

(3.1) $(h_F,h_M) = (H_F(z),H_M(z))$,

(3.2) $C(z) = f(H_F(z)W_F(z),H_M(z)W_M(z),I)$

where $H_F(z)$, $W_F(z)$, $H_M(z)$ and $W_M(z)$ are the match-specific hours of work and wages for the wife and for the husband, respectively. Consumption is defined by

(3.3) $C = f(w_M h_M, w_F h_F, I)$

where I denotes capital income and $f(\cdot)$ is the function that transforms gross income into consumption. In the calculation of $f(\cdot)$ for alternative values of h_j, j=M,F, the details of the tax structure of 1981 are taken into account.

As above $(T_{1F}(z),T_{1M}(z))$ represents the "distance" between qualifications offered and demanded relative to wife and husband.

Under assumptions that are straight forward extensions of the assumptions of the preceding section we can write

(3.4) $U(C(z),H_F(z),H_M(z),z) = v(C(z),H_F(z),H_M(z),T_{1F}(z),T_{1M}(z)) + \varepsilon(z)$

where $\{H_F(z),H_M(z),W_F(z),W_M(z),T_{1F}(z),T_{1M}(z),\varepsilon(z)\}$ is an enumeration of the points of a Poisson process on $R_+^4 X[0,1]^2 XR$.

The Swedish data contains no observations of education which implies that we cannot analyse participation. However, the Swedish participation rates, even for females, are very high (close to 90 percent) compared to other countries. Moreover, these restrictions on data means that we can at most estimate conditional densities, i.e., densities given the wage. The conditional density of hours given the realized wage is

$$(3.5) \quad \varphi(h_F, h_M | w_F, w_M) = \frac{g_{2F}(h_F) g_{2M}(h_M) \exp(\tilde{\psi}(h_F, h_M, w_F, w_M))}{\int\int g_{2F}(x) g_{2M}(y) \exp(\tilde{\psi}(x, y, w_F, w_M)) dx dy}$$

where

$$(3.6) \quad \tilde{\psi}(h_F, h_M, w_F, w_M) = \log[\int\int \exp(v(f(h_F w_F, h_M w_M, I), h_F, h_M, t_{1M}, t_{1F}) \cdot g_4(t_{1F}, t_{1M}) dt_{1F} dt_{1M})].$$

4. DATA

Data used in this study is a subsample from the Swedish Income Distribution Survey 1981 (HINK), collected by the Central Bureau of Statistics in Sweden. These annual and representative cross section surveys contain primary data from two rolling panels. Besides filled-in tax returns checked and approved by the tax authorities there are survey data based on interviews with both spouses. Moreover, data also contains information from the municipalities and the social security authorities. HINK-81 covers about 9 600 households and 24 500 individuals.

An HINK-household either consists of two adults and their children or one adult with or without children. An 18 years old person (or older) is defined as an adult. Married people are considered as adults, no matter their age. Cohabitants are defined as HINK-households provided that they are old enough to be adults.

The data set includes married couples or cohabitants with labor and capital income. Households with business income only or income from agriculture are excluded. The data set covers only working individuals.

In our subsample the age of women is between 26 and 65, while men are not older than 65. Couples of which one or both spouses have hourly wage rates below SEK 10 and above SEK 170, and with hours above 3 600 are excluded from the sample.

The income variable used is income from work, including sickness and parental benefits. Annual hours worked are calculated as hours worked a week times number of weeks worked during the year. The way hours are measured means that they correspond to contracted hours or normal working hours rather than to the actual hours worked. The advantage of using contracted hours (overtime included) is that one avoids unpredictable fluctuations due to sick-leaves. Economic theory has hardly anything to contribute in how sick-leaves occur and sick leaves have definitly nothing to do in a labor supply context. The hourly wage rate is calculated as income from work divided by hours worked a year. Dividing local income taxes paid by local taxable income yields the local tax rate.

The non-taxable allowances included in disposable income are the following:

- received transfers for childrens allowances,
- housing allowances,
- welfare payments,
- allowances for children between 16 and 18 that study,
- several kinds of pensions, life annuities and sickness benefits,
- several payments while serving in the military.

Of these allowances the housing allowances and the welfare payments depend on income.

Table 1 gives the summary statistics for the 1 649 households used in the estimation of the model.

Table 1. Sample statistics of married couples

Variables	Mean	St.dev.	Min	Max
Annual hours				
Males	2 021	327	240	3 484
Females	1 542	516	120	3 286
Full-time fractions				
Males	.69	.46	0	1.0
Females	.30	.46	0	1.0
Part-time fractions, females				
30 h/week	.11	.32	0	1.0
20 h/week	.16	.37	0	1.0
Hourly wage rates, SEK				
Males	55	22	11	163
Females	42	15	11	167
Gross annual earnings, SEK				
Males	110 000	47 000	0	639 000
Females	63 000	27 000	17 000	255 000
Marginal tax rates, pct.				
Males	63	14	22	85
Females	47	14	6	88
Age				
Males	44	10	22	64
Females	41	9	27	63
Household characteristics				
Annual net taxes paid, 1000 SEK	61	35	3	407
Disposable income, 1000 SEK	117	30	31	310
Number of children below 7	.38	.65	0	3
Number of children 7-17	.80	.92	0	7

5. EMPIRICAL SPECIFICATION AND ESTIMATION RESULTS

As noted in Section 2 we have estimated the conditional model given realized wage rates and given household characteristics that are supposed to influence the preferences and the qualifications. The observed variables that are supposed to influence preferences are age and number of children in the household less than 6 and above 6 years.

In order to estimate the model we need to specify functional forms for $\tilde{v}(C,h_F,h_M)$, $g_{3M}(h_M)$ and $g_{3F}(h_F)$ where

$$\tilde{v}(C,h_F,h_M) = \log[\iint \exp(v(C,h_F,h_M,t_{1M},t_{1F}))g_4(t_{1M},t_{1F})dt_{1M}dt_{1F}].$$

We have chosen $\tilde{v}(C,h_F,h_M)$ to be a Box-Cox type function, separable in leisure and consumption. This specification has been applied by several researchers and allows for fairly flexible income and substitution elasticities. Specifically

$$(5.1)\quad \tilde{v}(C,h_F,h_M) = \alpha_2\left(\frac{(10^{-5}C-0.3)^{\alpha_1}-1}{\alpha_1}\right) + \left(\frac{L_M{}^{\alpha_3}-1}{\alpha_3}\right)(\alpha_4 + \alpha_5\log A_M + \alpha_6(\log A_M)^2) + \left(\frac{L_F{}^{\alpha_7}-1}{\alpha_7}\right)(\alpha_8 + \alpha_9\log A_F + \alpha_{10}(\log A_F)^2 + \alpha_{11}CU6 + \alpha_{12}CO6) + \alpha_{13}L_F^{0.5\alpha_3}L_M^{0.5\alpha_7}$$

where A_F, A_M are the age of the wife and the husband, respectively, CU6 and CO6 are number of children less than 6 and above 6 years, C is given by (3.3), L_k is leisure for gender k = M,F, defined as

$$L_k = 1 - h_k/8760,$$

and α_j, j = 1,2,...13, are unknown parameters. If $\alpha_1<1$, $\alpha_3<1$, $\alpha_7<1$, $\alpha_2>0$,

$$\alpha_4 + \alpha_5\log A_M + \alpha_6(\log A_M)^2 > 0,$$

and

$$\alpha_8 + \alpha_9\log A_F + \alpha_{10}(\log A_F)^2 + \alpha_{11}CU6 + \alpha_{12}CO6 > 0$$

then $\tilde{v}(C,h_F,h_M)$ is increasing in C, decreasing in (h_F,h_M) for fixed C and strictly concave in (C,h_F,h_M).

The tax rules of 1981 used in estimating the model are described in detail in Anderson et al (1988).

The densities of offered hours, $g_{3k}(h_k)$, k=F,M, are assumed uniform except for a peak at full-time hours for males and peaks at full-time, 2/3 part-time and part-time hours for females. Unless this or analogous assumptions are made about the opportunity densities it is not possible to separate all the structural coefficients in the mean utility function from the parameters of the opportunity densities for hours. Note that uniformly distributed offered hours is in accordance with the conditions of a perfect competitive economy. Thus, the peaks in the hours distribution capture institutional restrictions and hence market imperfections in economy.

It is of interest to note that since the logarithm of the opportunity density of hours and the mean utility function enter symmetrically into (3.5) it would, however, be possible to interpret the peaks as stemming from preferences in which case the offered hours could be generated by a uniform distribution. Although this seems unlikely we can perform policy simulations with respect to changes in demographic variables, taxes and wage rates based on the estimated model that are consistent with either interpretations. A necessasy requirement is that preferences and the opportunity density of hours are kept fixed.

The estimation is based on a procedure suggested by McFadden (1978) which yields results that are close to the full information maximum likelihood method. We are not able to use the exact likelihood function to estimate the model because the evaluation of the integrals in (3.5) would be too costly and cumbersome. The estimation procedure applied replaces the double integral in the denominators of the densities by a sum over 30, (alternatively 70), random points, where each term is adjusted by appropriate weights. In other words, the continuous logit model is replaced by a discrete logit version. McFadden has demonstrated that this method yields consistent and asymptotically normal parameter estimates. We found the McFadden estimation procedure to be remarkably efficient. Our experience suggests that it is enough to replace the choice set by 10 random points (draws in R_+^4) to obtain good results. When the number of draws increases to 30 then the estimated standard errors seem to be close to the corresponding ones obtained by the full maximum likelihood procedure.

The results of the estimation are reported in table 2.

Table 2. Estimates of the parameters of the utility function and of the opportunity density

Variables	Coefficients	Estimates	t-values
Consumption	α_1	0.574	9.4
	α_2	9.278	11.4
Male leisure	α_3	-4.607	5.8
	α_4	174.644	3.0
	α_5	-91.188	3.0
	α_6	12.371	3.1
Female leisure	α_7	-4.106	6.5
	α_8	153.041	2.5
	α_9	-78.834	2.4
	α_{10}	10.876	2.5
	α_{11}	1.541	3.8
	α_{12}	0.805	3.1
Leisure interaction term	α_{13}	1.698	1.5
Full-time peak, males	α_{14}	3.424	47.1
Full-time peak, females	α_{15}	2.814	29.1
2/3 part-time peak, females	α_{16}	1.454	13.5
Part-time peak, females	α_{17}	1.830	18.8

Note that most parameters are rather precisely determined (apart from the cross leisure term) and they have the theoretically expected signs.

The estimates imply that the mean utility function is an increasing and strictly concave function in consumption and leisure. The males marginal mean utility of leisure attains a minimum at the age of 41.9 years and in the case of females, at the age of 35 years.

Figures 1, 2 and 3 give the observed and simulated distributions for hours of work and consumption. These figures demonstrate that the model is able to reproduce the observed distributions remarkably well.

Figure 1. Observed and simulated hours of work for females

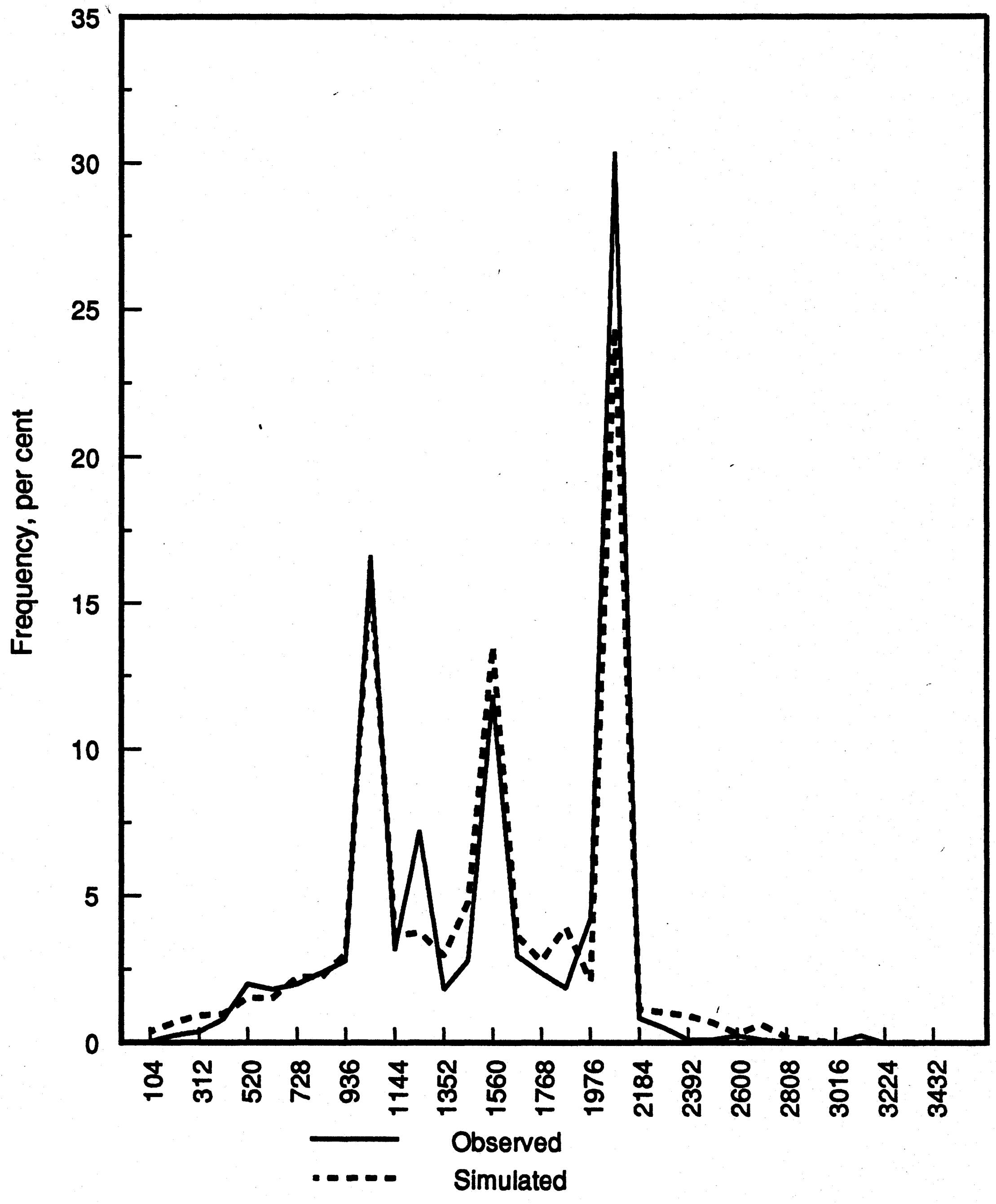
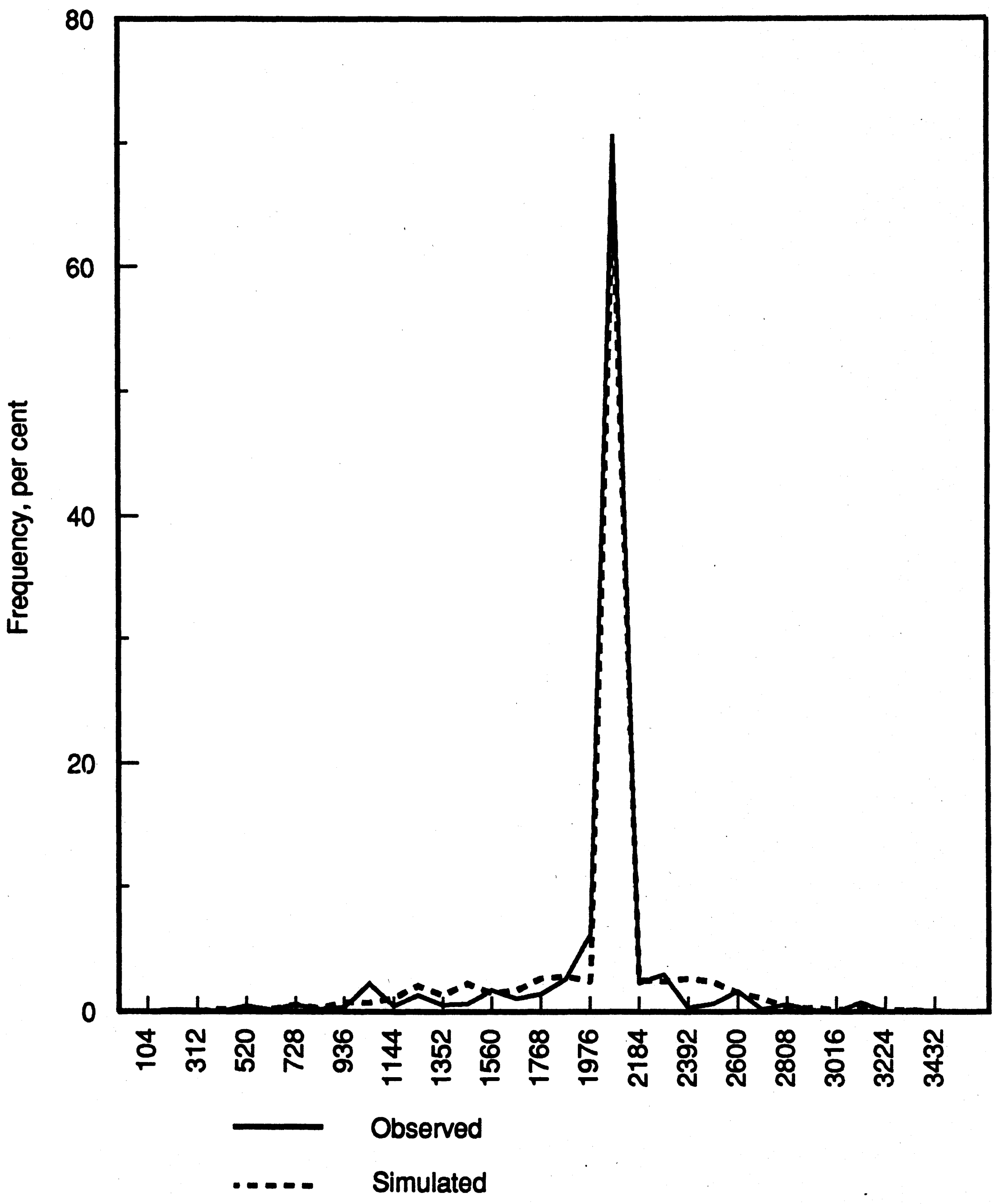
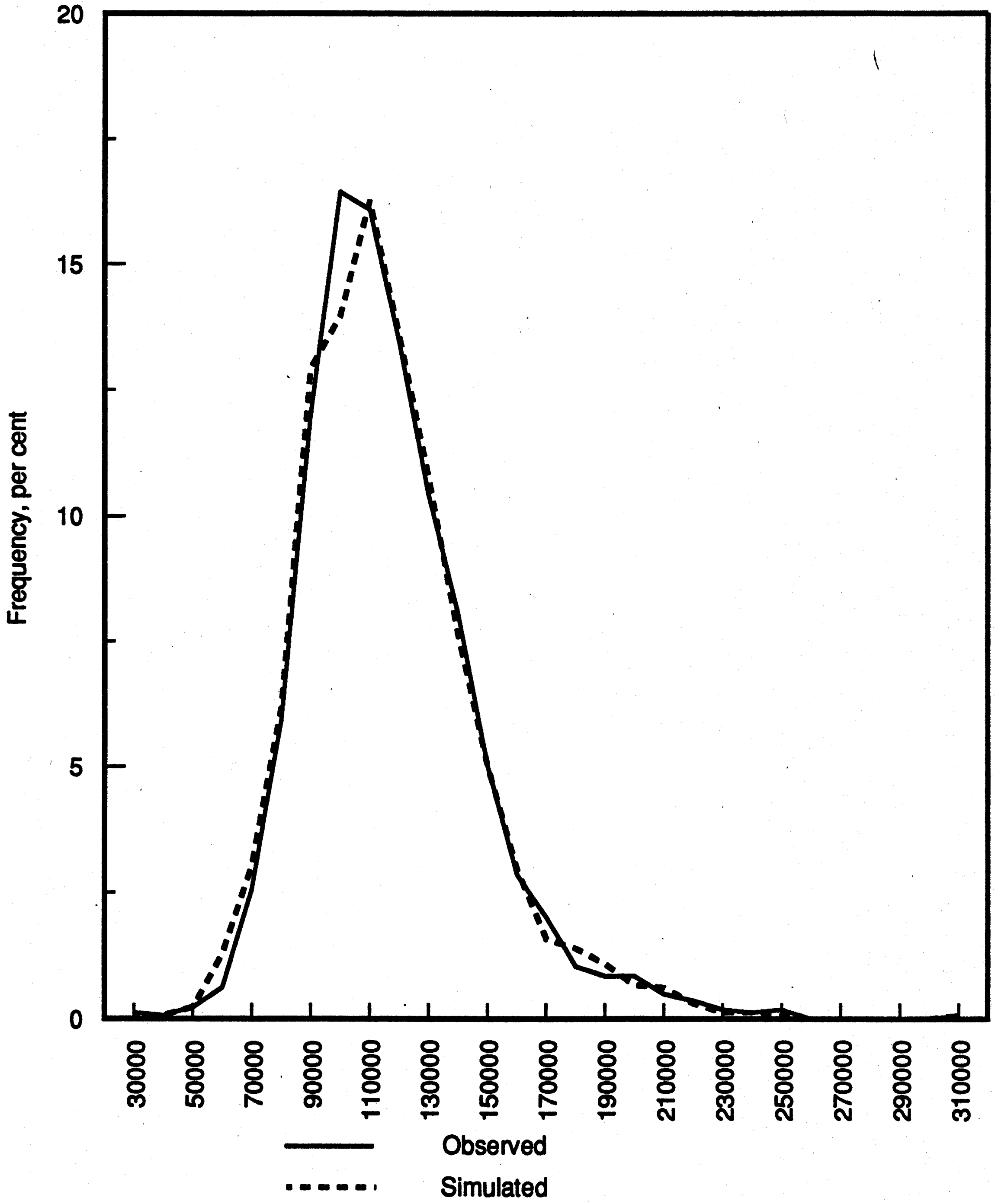


Figure 2. Observed and simulated hours of work for males



Figur 3. Observed and simulated consumption for married couples.



In Table 3 we report what we have called aggregate Cournot elasticities. They are calculated as follows: The model is used to simulate (stochastic simulations) the labor supply for each household (wife and husband) under the current regime and when the wage rates are increased by 10 per cent. The aggregate elasticity of, for example, female labor supply is obtained by calculating the relative change in the mean (over all females in the sample) female labor supply that results from a 1 per cent wage increase. Note that the "estimates" in Table 3 are based on 10 sets of simulations and that the standard deviations inform about the simulation uncertainty. The Slutsky elasticities are derived in the same manner, but under the restriction that utility levels should remain unchanged.

Table 3. Aggregate labor supply elasticities*) for males and females

Type of elasticity			Male elasticities: Own wage elasticities	Male elasticities: Cross elasticities	Female elasticities: Own wage elasticities	Female elasticities: Cross elasticities
Elasticity of conditional expectation of total supply of hours	Cournot	I	.054 (.018)	-.038 (.018)	.069 (.082)	-.031 (.018)
	Cournot	II	-.025 (.002)	-.019 (.003)	034 (.010)	-.067 (.007)
	Cournot	III	-.047 (.009)	-.024 (.011)	-0.37 (.022)	-.072 (.026)
	Cournot	IV	-.020 (.001)	-.021 (.002)	.070 (.006)	-.065 (.008)
	Slutsky	I	.049 (.013)	-.038 (.024)	.813 (.105)	.026 (.044)
	Slutsky	II	-.009 (.002)	-.005 (.002)	.062 (.009)	-.004 (.003)
	Slutsky	III	-.031 (.010)	-.006 (.006)	-.005 (.017)	-.017 (.025)
	Slutsky	IV	-.006 (.002)	-.008 (.002)	.105 (.007)	-.003 (.005)

*) Standard deviations in parenthesis.
Note that I = 10 per cent poorest households
II = 80 per cent in the middle of the distribution of disposable income
III = 10 per cent richest households
IV = all households

The aggregate elasticities in Table 3 indicate that labor supply is rather inelastic. The conditional Cournot and Slutsky elasticities demonstrate, however, that the labor supply responses depend on the households disposable incomes. Both female and male members of the poor households increase their hours of work, while the members of the rich households reduce their hours of work as a result of wage increments.

A striking result in Table 3 is that the wage elasticities are declining with household income and that some of the elasticities are negative. The elasticities among the poorest are positive while they are negative among the richest.

As reported above the deterministic part of the utility function or, more precisely, the mean utility across feasible matches for given w and h, is a concave function in C and h. However, the presence of random tasteshifters ($\varepsilon(z)$) and latent constraint on hours opens for the possibility of negative aggregate Slutsky elasticities.

6. POLICY SIMULATION

This section describes the nature and the purpose of the simulation experiments. It should be noted that our model is a labor supply model which treats wages as exogeneous variables. Hence we are only able to perform conditional simulation experiments, given the wage distribution or given specified changes in wage levels.

Let $V(h_F, h_M, w_F, w_M)$ denote the value of the utility function when individuals have maximized utility with respect to non-pecuniary attributes given specified levels of hours and wages, i.e.

$$(6.1) \quad V(h_F, h_M, w_F, w_M) = \max_z \left(v(C(z), H_F(z), H_M(z), T_{1F}(z), T_{1M}(z)) + \varepsilon(z)\right).$$

given $H_F(z)=h_F, H_M(z)=h_M$
$W_F(z)=w_F, W_M(z)=w_M$

Replacing h_F and h_M in (6.1) by the stochastic counterparts it can be demonstrated that

$$V(H_F(z), H_M(z), w_F, w_M) \overset{D}{=} \tilde{\psi}(H_F(z), H_M(z), w_F(z), w_M(z)) + \tilde{\varepsilon}(z)$$

where $\tilde{\psi}$ is defined by (3.6), $\overset{D}{=}$ means equality in distribution and where $\{H_F(z), H_M(z), \tilde{\varepsilon}(z)\}$ are the points of a Poisson process with intensity measure

$$\mu g_{2F}(h_F) g_{2M}(h_M) \cdot e^{-\varepsilon} d\varepsilon.$$

Since we have estimated $g_{2F}(h_F), g_{2M}(h_M)$ and $\tilde{\psi}(h_F, h_M, w_F, w_M)$ we are able to perform policy simulations (changes in tax rates) given the wage rate and given that the couple works provided it makes sense to keep the opportunity densities $g_{2F}(h_F)$, $g_{2M}(h_M)$ and $g_4(t_{1F},t_{1M})$ unchanged. Recall that the densities of offered hours is assumed to be determined by institutional constraints and firm-specific hours of work regulations. These constraints are not likely to change as a consequence of say, changes in the tax system.

To keep $g_4(t_{1F},t_{1M})$ constant in the simulations means that the individual sets of feasible market matches with respect to qualifications, as measured by $(T_{1F}(z),T_{1M}(z))$, are unaffected by the tax rate changes. Again, this stresses the fact that this is not a complete equilibrium model. This fact should be kept in mind in the interpretation of the simulation results.

One purpose of the simulation experiments is to examine the influence of certain tax reforms on labor supply, income levels and income inequality among households (married couples with or without children). The basic income concepts are gross income (Y) and disposable income (equal to consumption C) defined as;

$$(6.2) \qquad Y = w_F h_F + w_M h_M + I_1 + I_2,$$

and

$$(6.3) \qquad C = Y - S(w_F h_F, w_M h_M, I_1),$$

where I_1 and I_2 are taxable and non-taxable non-labor family income, respectively, and S is the tax function.

Income inequality is examined by employing a transfer sensitive inequality measure. This measure of inequality, denoted the A-coefficient, is discussed in Aaberge (1986). The A-coefficient has a similar geometric interpretation as the Gini-coefficient, but gives more weight to transfers that occur in the lower part of the distribution. The maximum attainable value of the A-coefficient is 1, which corresponds to the distribution where one family has all income, while the minimum attainable value is 0, which corresponds to perfect equality. The mathematical definition and some other relevant information are given in Appendix 1.

The simulation of the model can be performed as follows:

Draw n points (say),

$$\{H_F(z), H_M(z), \tilde{\varepsilon}(z)\}, \qquad z = 1,2,\ldots,n.$$

Here $\{H_F(z)\}$ and $\{H_M(z)\}$ are drawn from uniform distributions with full- and part-time peaks and $\{\tilde{\varepsilon}(z)\}$ are drawn from the extreme value distribution, $\exp(-e^{-\varepsilon})$. Find the realized hours $(H_F(\hat{z}), H_M(\hat{z}))$ given the wages (w_F, w_M) by maximizing

$$\tilde{\psi}(H_F(z), H_M(z), w_F, w_M) + \tilde{\varepsilon}(z)$$

with respect to $z = 1,2,\ldots,n$. Repeat this procedure for every household in the sample. When n is large this procedure yields results that are close to an "exact" simulation of the model.

The simulation procedure we have followed in the present paper is a refinement of the one described above and it is unbiased for finite n and also more efficient. This procedure will be described and analyzed elsewhere.

6.1. Lump-sum and proportional taxes on gross earnings

The personal income tax system in Sweden in 1981 was designed to have a progressive structure. To a certain extent the redistributional effect of this structure was, however, distorted by the rules of deductions. In fact, the tax system combined with the benefit system is not uniformly progressive. The purpose of this section is to study effects on labor supply and income distribution of replacing the 1981 tax rules by proportional taxes on gross earnings and lump-sum taxes, respectively. The proportional tax rate is derived under the constraint that the personal income tax revenue (among those couples who work) should remain unchanged and equal to the revenue in 1981. This tax rate is found to be approximately 32 per cent, which is 3 per cent points less than the actual tax level in 1981. The lump-sum amounts are obtained from the conditions that each of the households should have utility levels equal to their utility levels under the 1981 rules.

The results of the three simulation experiments are displayed in Tables 4 and 5. We start with commenting on the lump-sum case. Although it is impossible to practice this system, it yields information about the upper limit for the personal income tax revenue. By definition all marginal and distortive effects of taxation are removed. Therefore, lump-sum taxation should bring forward the labor supply potential in the economy. From Table 4 we observe that hours supplied among females and among males increase by 27 per cent and 21 per cent, respectively, relatively to the 1981 rules. The households gross incomes increase by 27 per cent, which indicates the potential increase in earnings that can be obtained from tax reforms.

Table 4. Annual hours of work, gross earnings, gross income, taxes and disposable income under three different tax regimes. Means

Tax regime	Annual hours of work		Gross earnings (SEK)		Gross income	Taxes	Disposable income
	F	M	F	M	Households		
1981 tax rules	1 518	2 014	63 400	110 700	179 300	63 000	116 200
Proportional taxes[1)]	1 678	2 209	72 000	124 200	201 400	63 000	138 400
Lump-sum taxes[2)]	1 925	2 441	82 700	139 100	227 000	79 200	147 800

1) The proportional tax rate (approximately 32 per cent) on gross earnings is obtained by simulating the model under the restriction of a constant tax revenue equal to the revenue under the 1981 rules.

2) Individual lump-sum taxes are derived by simulating the model given that each households utility level should be equal to the level under the 1981 rules.

Table 5 demonstrates that lump-sum taxation increases income inequality among households in spite of reduced differences in hours of work and gross earnings among females.

From a practical point of view a more relevant tax reform is to replace the 1981 rules by proportional taxes on gross earnings. By introducing this reform, we observe from table 4 that labor supply both among females and males increase by approximately 10 per cent. Gross household income increases by 12 per cent or about 46 per cent of the increase obtained when the 1981 rules are replaced by lump-sum taxes.

From Table 5 we realize that the introduction of proportional taxation increases the level of inequality in the distribution of disposable household income by 39 per cent (measured by the A-coefficient). If, alternatively the Gini-coefficient is applied, see Appendix 2, the increase is estimated to be 49 per cent. This means that the central part of the distribution of disposable household income is more strongly affected by the tax reform than the lower part of the distribution. The last column of Table 5 gives the ratio between the A-inequalities of the distributions of disposable and gross income and can be interpreted as an aggregate estimate of the degree of progression.

Thus, the main conclusion so far is that if the 1981 rules are replaced by proportional taxes the economy will be stimulated at the expense of increased income inequality.

Table 5. A-inequality* in distributions of annual hours of work, gross earnings, gross income and disposable income under three different tax regimes

Tax regime	Annual hours of work		Gross earnings		Gross income	Disposable income	Degree of aggregate progression
	F	M	F	M	Households		
1981 tax rules	.318 (.006)	.154 (.006)	.390 (.007)	.324 (.006)	.258 (.005)	.205 (.004)	.79
Proportional taxes	.312 (.006)	.143 (.005)	.418 (.007)	.351 (.006)	.284 (.005)	.284 (.005)	1.00
Lump-sum taxes	.244 (.006)	.153 (.004)	.377 (.007)	.371 (.006)	.295 (.005)	.256 (.004)	.87

* Standard deviations in parenthesis.

6.2. Excess burden

In the discussion above we have ignored the fact that the costs of increased efforts is a reduction in leisure. We therefore now discuss a money measure of the changes in utility as a result of changes in the tax system and estimate the cost taxation based on this measure.

Let K denote the level of equivalent variation of a household defined by

$$(6.3) \quad V(f_1,0) = V(f_0,K)$$

where

$$(6.4) \quad V(f,K) = \max_z[\tilde{v}(f(H_F(z)w_F, H_M(z)w_M, I) + K, H_F(z), H_M(z)) + \varepsilon(z)]$$

f_0 denotes the 1981 rules, and f_1 denotes the above mentioned system of proportional taxes on gross earnings with a tax rate approximately equal to 32 per cent. $V(f,K)$ is clearly the indirect utility function given wages and tax rules.

Our measure of excess burden is the ratio of the mean level of equivalent variations to the initial mean tax revenue.

Recall that the indirect utility is stochastic and its values can be obtained from (6.4) by inserting the values of hours, wages and the taste-shifter that correspond to the chosen match. Since the indirect utility is random, so is K.

Below we report the simulation results regarding the excess burden of taxation when the 1981 rules are compared to lump-sum taxes and to a system of proportional taxes on gross earnings.

By aggregating the individual lump-sum taxes, we get a total tax revenue of SEK 79 200 which is 26 per cent higher than the tax revenue under the 1981 rules. Thus, the excess burden of taxation, when 1981 rules are compared to lump-sum taxes, is 26 per cent. This burden is low compared to the results for Norway given in Aaberge et.al. (1989). The excess burden of the Norwegian 1979 tax system was estimated to 61 per cent. Consequently the excess burden of taxation in Sweden indicates considerable less loss from collecting taxes through the actual system than in Norway. The main reason why the excess burden of taxation is lower in Sweden than in Norway is differences in the contraints caused by taxes and hours restrictions.

The mean level of K relative to initial tax revenue is estimated to be 16.7 per cent. This is by definition lower than the excess burden when the 1981 rules are replaced by lump-sum taxes. By adding the compensation payment to the initial taxes, it was found that this sum amounts to 93 per cent of the lump-sum transfers.

Table 6. Equivalent variations* (K) for the 1981 rules versus proportional taxes on wage earnings

Mean level of K (SEK)	Mean level of K relative to mean level of initial taxes, per cent	A-inequality in the distribution of K, given K<0	given K>0
10 550 (650)	16.7	0.618 (0.011)	0.675 (0.009)

* Standard deviation in parenthesis.

In order to examine the redistributional effect we consider those loosing and those gaining from a switch to proportional taxation. Specifically we have estimated some key measures for these two groups. Table 7 displays the respective means for labor supply and income variables. We observe that the majority of the households - 62 per cent - is gaining from this tax reform. Both female and male members of these households have on average higher wage rates than female and male members of the households loosing from the tax reform. We observe that the households that are gaining increase their annual hours of work relatively more - 12 versus 8 per cent - than the households that are loosing.

Table 7. Characteristics of those who gain from switching to proportional taxes (K>0) and those who loose (K<0). Means

		Proportion of the households	Mean level of K (SEK)	Hourly wage rates (SEK) F	Hourly wage rates (SEK) M	Annual hours of work F	Annual hours of work M	Wage earnings (SEK) F	Wage earnings (SEK) M	Gross household income (SEK)	Taxes (SEK)	Disposable income (SEK)
1981 tax rules	Winners	0.62	22500	44.6	60.8	1558	2022	69600	123000	199600	79400	120300
	Loosers	0.38	-8600	36.9	45.3	1452	2001	53300	90900	146500	36700	109800
Proportional taxes	Winners	-	-	-	-	1732	2264	79900	141000	228000	71000	157000
	Loosers	-	-	-	-	1591	2121	59300	97100	158600	50200	108400

Table 8 gives some information about the mobility induced by the switch to proportional taxation. Only 50 per cent of the 10 per cent richest households under the 1981 rules still stay in this fraction of the population after the tax-change. The corresponding result for the 10 per cent poorest is 64 per cent. Among the 10 per cent richest there are 72 per cent who gain from the tax reform, while 43 per cent of the 10 per cent poorest gain from the tax reform. Those who gain among the poorest and among the richest gain on average SEK 7 700 and SEK 45 900, respectively. There are fewer loosers among the richest than among the poorest. However, the richest loose on average more than twice the amount of the loss of the loosers among the poorest.

Table 8. Flows from and equivalent variations in the lower and the upper 10 per cent of the distribution of disposable income when the 1981-rules are replaced by proportional taxes

	The proportion of the income decile which still stay in this decile after the tax change	Proportion of the income decile with K>0	Mean level of K for those with K>0	Proportion of the income decile with K<0	Mean level of K for those with K<0
The 10 per cent poorest under the 1981-rules	0.64	0.43	7 700	0.57	-6 700
The 10 per cent richest under the 1981-rules	0.50	0.72	45 900	0.28	-17 700

Tables 9 and 10 give some characteristics of the households who are located in the 10 per cent lower and the 10 per cent upper parts of the distribution of disposable income under the 1981 rules. The first line gives the characteristics under the 1981 rules and the second line gives the characteristics of the very same households under a system of proportional taxes on gross earnings. The results in tables 9 and 10 show that female and male members of the 10 per cent poorest households on average increase their labor supply by 28 and 13 per cent, respectively. The corresponding results for the 10 per cent richest households are an increase of 6 per cent and 12 per cent, respectively. The implications of the increased labor supply are higher disposable incomes both among poor and rich households. The poor households are stimulated both by positive substitution and income effects, while the rich households meet positive substitution effects and negative income effects. However, among the majority of the rich the substitution effect dominates the income effect.

Table 9. Characteristics of the 10 per cent poorest (disposable income) households under the 1981-rules

	Annual hours of work		Wage earnings (SEK)		Gross household income (SEK)	Taxes (SEK)	Disposable income (SEK)
	F	M	F	M			
Under the 1981-rules	1 043	1 761	33 500	66 700	102 800	29 500	73 300
Proportional taxes	1 336	1 983	44 700	77 100	124 500	39 000	85 500

Table 10. Characteristics of the 10 per cent richest households under the 1981-rules

	Annual hours of work		Wage earnings (SEK)		Gross household income (SEK)	Taxes (SEK)	Disposable income (SEK)
	F	M	F	M			
Under the 1981-rules	1 713	2 128	98 200	182 200	289 100	111 600	177 500
Proportional taxes	1 814	2 388	107 200	208 800	324 700	101 500	223 200

7. CONCLUSIONS

In recent years there have been important developments in the econometric modeling methodology of labor supply. The most well known of these new approaches is the Hausman type model of labor supply. The most important and new aspect in this approach relative to previous analyses was the treatment of the budget constraint. In most countries taxes are not uniformingly progressive with income which implies a non-convex budget set. The purpose of the Hausman approach was to account for this non-convexity when estimating labor supply functions. This approach has, however, only proved to be tractable when labor supply curves are linear or quadratic, budget constraints are weakly non-convex and markets are free from imperfections. Moreover most of the Hausman type models have been estimated on data sets in which paid taxes are not observed, but imputed from tax rules.

The present study tries to overcome some of these shortcomings through a quite different approach which allows for rather complex non-convex budget constraints, rather general and highly non-linear supply curves and imperfect markets with latent institutional constraints. Moreover paid rather than imputed taxes are used in estimating the model.

Estimates on Swedish data show that our approach gives a less elastic labor supply than the results obtained in previous studies on Swedish data based on the Hausman type approach as reported in studies by Blomquist op cit. There are several factors contributing to this difference. The specifications of the constraints and preferences differ but it is hard to "calculate" the contribution from each of these components. Despite the fact that labor supply is rather inelastic as measured by wage elasticities, the response in labor supply of replacing the "present" tax system in 1981 by a flat tax rate on wage earnings is clearly of some importance. The corresponding costs of taxation is also substantial.

In an analogue study of the Norwegian labor supply we found labor supply to be more elastic than in Sweden and consequently the burden of taxation to be higher in Norway than in Sweden. There are several factors contributing to this difference in the responsiveness pf labor supply to changes in wages and tax rates. The following three aspects of the constraints facing the individuals in the two countries are important. First, at the beginning of the 1980s the tax systems of the two countries differed at one important point. In Norway there was an option of joint taxation while in Sweden a corresponding option did not exist. Second, the leave of absence rules when a woman gives birth to a child were and still are more generous in Sweden than in Norway. For these and other reasons the participation rates and working hours were higher among females in Sweden than in Norway. The data used to estimate the models differ substantial between the two countries. In Sweden contracted hours were observed while in Norway hours were obtained by dividing labor income by observed wage rates.

Estimates of an excess burden of taxation, ranging from 16 per cent in Sweden to 48 per cent in Norway, at the beginning of the 1980s, indicate that costs of taxation in Scandinavian countries have been quite large. And it supports the view that the gain from changing the tax system towards proportional taxes could be substantial. In Sweden this gain has to be weighted against the social cost of increasing income inequality as reported in table 5 above.

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APPENDIX 1. MEASUREMENT OF INEQUALITY

A common approach for measuring inequality in distributions of income is to employ the Gini coefficient, which satisfies the principles of scale invariance and transfers. The principle of scale invariance states that inequality should remain unaffected if each income is altered by the same proportion and it requires, therefore, the inequality measure to be independent of the scale of measurement. The principle of transfers implies that if a transfer of income takes place from a richer to a poorer person without reversions of the relative positions, the inequality diminishes.

As is wellkonown, the Gini coefficient (G) is related to the Lorenz curve (L) in the following way

$$\text{(A.1)} \qquad G = \int_0^1 [1-2L(u)]du.$$

The Gini coefficient offers a method for ranking distributions and quatifying the differences in inequality between distributions. This strategy, however, suffers from certain inconveniencies. Evidently, no single measure can reflect all aspects of inequality of a distribution, only summarize it to a certain extent. Consequently, it is important to have alternatives to the Gini coefficient. As pointed out by Atkinson (1970), the Gini coefficient assigns more weight to transfers in the centre of a unimodal distribution that at the tails. As an alternative to the Gini coefficient, we will employ an inequality measure (the A-coefficient) that assigns more weight transfers at the lower tail than at the centre and the upper tail. The A-coefficient, see Aaberge (1986), has a similar geometric interpretation and relation to the inequality curve M defined by

$$\text{(A.2)} \qquad M(u) = \frac{E[X|X \le F^{-1}(u)]}{EX}, \qquad 0 \le u \le 1,$$

as the Gini coefficient has to the Lorenz curve. Here X has distribution function F. The A-coefficient is defined by

$$\text{(A.3)} \qquad A = \int_0^1 [1-M(u)]du.$$

If X is an income variable, then M(u) for a fixed u expresses the ratio between the mean income of the poorest 100u per cent of the population and the mean income of the population. As is well-known, the egalitarian line of the Lorenz curve is the straight line joining the points (0.0) and (1.1). The egalitarian line of the M-curve is the horizontal line joining the points (0.1) and (1.1). Thus, the universe of M-curves is bounded by a unit square, while the universe of Lorentz curves is bounded by a triangle. Therefore visually, there is a sharper distinction between two different M-curves than between the two corresponding Lorenz curves. Note that the M-curve will be equal to the diagonal line (M(u)=u) if and only if the underlying distribution is uniform (0,a) for an arbitrary a. The A-coefficient then takes the value 0.5, while the maximum attainable value is 1 and the minimum attainable value is 0.

Note that M(u) = L(u)/u, which implies

$$(A.4) \quad A = \int_0^1 [1 - \frac{L(u)}{u}]du.$$

APPENDIX 2. ESTIMATES OF INEQUALITY BASED ON THE GINI COEFFICIENT

In the tables below we have used a numbering which will facilitate comparison with the corresponding tables for the A-coefficient. Therefore, table G5 corresponds to table 5 and table G6 corresponds to table 6.

Table G5. G-inequality* in distributions of annual hours of work, gross earning, gross income and disposable income under three different tax regimes

Tax regime	Annual hours of work		Gross earnings		Gross income	Dis-posable income	Degree of aggregate progression
	F	M	F	M	Households		
1981 tax rules	.198 (.004)	.076 (.003)	.266 (.006)	.229 (.005)	.181 (.004)	.138 (.003)	.76
Propor-tional taxes	.185 (.004)	.088 (.003)	.291 (.006)	.259 (.005)	.205 (.004)	.205 (.004)	1.00
Lump-sum taxes	.139 (.004)	.107 (.002)	.264 (.007)	.280 (.005)	.216 (.004)	.185 (.003)	.86

* Standard deviations in parenthesis.

Table G6. Equivalent variations* (K) for the 1981-rules versus proportional taxes on wage earnings

Mean level of K (SEK)	Mean level of K relative to mean level of initial taxes, per cent	G-inequality in the distribution of K, given K<0	given K>0
10 550 (650)	16.7	0.618 (0.011)	0.674 (0.009)

* Standard deviation in parenthesis.

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