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NON-CONVEX BUDGET SET, HOURS RESTRICTIONS AND LABOR SUPPLY IN SWEDEN

BY

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Abstract

This paper presents the results of a labor supply study based on Swedish labor market data and data from filled-in tax returns. The model is designed to deal with non-convex budget sets (implied by the tax and social security rules), restrictions on hours and with the joint decisions of married couples. A novel feature is the assumption that the basic choice variable is unobservable, here denoted match. Given a match, wage, hours of work and non-pecuniary attributes follow. The individuals are assumed to select the optimal match from the maximization of utility. A specific hours of work distribution is derived and estimated on data from 1981. The results indicate a rather weak wage responsiveness in Swedish labor supply. Several policy simulations have been performed.

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1. Introduction

This paper presents the results of a study of Swedish labor market data and data from filled-in tax returns. This Swedish study is part of a labor supply project at the Central Bureau of Statistics, Oslo and the University of Oslo in which the effects of taxation and hours restrictions on labor supply in Nordic as well as in other European countries are studied. The econometrics of the labor supply model is outlined in Dagsvik and Strøm (1988) and in Dagsvik (1988).

There are three essential features of the model. First, the model is designed to deal with non-convex budget sets because the tax and benefit systems in most countries are not uniformly progressive. Social security and transfer payment rules, together with options of joint/separate taxation for married couples in countries like Norway, UK, France and West-Germany, turn an otherwise progressive structure into a regressive tax structure over certain ranges of income. In Appendix 2 we report how the total marginal effects from income taxes, social security, kindergarten fees and housing allowances vary with income in Sweden. The reported variations in total marginal 'taxes' indicate that the Swedish system is far from being uniformly progressive. The budget sets of the households are clearly non-convex. Of course, an interesting question is how important it is to take all details of the tax and benefit system into account when analyzing labor supply decisions. In Dagsvik and Strøm (1988) this question is analyzed. Although the results of their study indicate that the ignorance of the non-convexity of the budget set might not imply biased estimates, a model designed to handle a detailed specification of the budget set is preferable in a policy simulation context.

Most of the previous labor supply studies have used the counterfactual assumption of a convex smooth budget set (cf. Rosen (1976), Nakamura and Nakamura (1981), Wales and Woodland (1979), Blundell et al (1987), Ransom (1987) and Kohlase (1986). Only recently there have been attempts to take the non-convexity properties of the tax structure into account. These attempts are usually versions of the approach suggested by Burtless and Hausman (1978) (cf. Arrufat and Zabalza (1986), Hausman (1980) and (1986) and Hausman and Ruud, (1984)). However, from an econometric point of view the Hausman approach is not ideal due to strong assumptions about functional forms. Moreover, when the number of tax brackets gets large, the Hausman model seems complicated to estimate.

The second key feature of the model is its ability to deal with restrictions on hours. In many countries individuals are not given the full freedom to choose how many hours they would like to work. Institutional arrangements, wage-hours contracts in unionized economies and demand constraints restrict severely the hours decisions of individuals. These restrictions are reflected in the observed frequencies of hours worked with a typical two-peak distribution for females (full time/part time) and one-peak distribution for males. Most likely, these concentrations over certain narrow ranges of hours are not only due to preferences.

Finally, in contrast to the traditional approach in the analysis of labor supply, see Killingsworth (1983) for a review, we have adopted a theoretical framework that is related to Tinbergen (1956) in which some of the unobservables are choice variables. Specifically, the choice environment is assumed to consist of a set of opportunities, called matches, where each match corresponds to a particular combination of individual abilities offered and skills required to perform certain tasks or activities as well as non-skill attributes of the matches. The quality of a match, relative to the individual, depends on the "tension" between the abilities offered and skills demanded as well as of non-pecuniary attributes related to these activities. Each match is characterized by wage rates, hours of work and non-pecuniary attributes. The individual is assumed to maximize his utility with respect to latent matches.

Previous labor supply studies in Sweden are Axelsson et al (1981), Gustafsson and Jacobson (1983) and Blomquist (1983). In Axelsson et al hours supplied are analyzed but taxes are almost ignored. Gustafsson and Jacobsson (1983) analyze the effects of wages, income and socio-economic characteristics on female participation in the labor market. Taxes are ignored. Blomquist (1983) applies the Hausman approach in the estimation of hours supplied by men. Taxes, but not all parts of the tax and benefit system, are included. The data set is from 1973-74 and the most noteworthy result is a rather weak effect of wages on labor supply. The own-wage elasticity is calculated to .08 for mean sample values of exogenous variables. Possible restrictions on hours are ignored. In Ljones and Strøm (1986) another data set from 1981 than the one used here is analysed. The main difference between the two studies is that in Ljones and Strøm both participation and hours worked are analyzed while in the present paper only hours supplied, given participation, is analysed. Futhermore, in Ljones and Strøm restrictions on hours are not accounted for in the same explicit way as in the present paper. Finally, the data set used in the present paper is more carefully checked and it includes more observations than the one used by Ljones and Strøm. Comparisons of results will be given below.

The paper is organized as follows. In Section 2 a brief description of the model is given. Section 3 and the two appendices present data and tax rules. Estimation results are given in Section 4 and in Section 5 we report the results of policy simulations.

2. The model and econometric specifications

The labor supply model presented in this paper is designed to analyze the effects of taxes, transfers, income related fees and non-labor income, on the labor supply of working, married couples.

Our point of departure is that some of the unobservables are choice variables and that the individual's choice of optimal values for these variables are not made independently of the level of consumption and hours worked. These two variables are the only choice variables that are observed.

Important examples of unobserved choice variables are type of job and type of leisure or non-market activities such as schooling, sports, household activities, etc. By type of job we understand the specific tasks performed at the job, the type of qualifications demanded to perform these tasks and other attributes of the job like working conditions, location, etc. Similarly, non-market alternatives may be identified in an analogous way. Non-market alternatives also demand certain skills to perform the tasks associated with the different types of activities.

The individual's set of available opportunities depends on his abilities. These are a mixture of inherited abilities and qualifications obtained through education and training. Following Tinbergen (1956) the individual's choice of market and non-market positions is a process in which the individuals try to obtain the best match of personal abilities and skills required to perform certain activities. We extend Tinbergen's approach by assuming that attributes of the different activities might have a direct influence on preferences. We call a particular combination of abilities offered, skills required to perform certain tasks and non-skill attributes associated with these tasks a match. We assume that the individual finds the optimal match, among the set of feasible matches, by evaluating how well he is fit for a particular task jointly with his taste for that task. Matches are not observed and they are present in the model as latent choice opportunities. For a detailed exposition of the model and its stochastic properties the reader is referred to Dagsvik (1988) and Dagsvik and Strøm (1988).

We enumerate the universe of matches by a discrete variable, $z=1,2,\ldots$. Let $U(h,C,z)$ be the utility of hours, consumption and other characteristics of jobs that affect utility and implied by a given match. The index z appearing in the utility function is meant to capture these other characteristics.

We assume that there is no uncertainty from the individual's viewpoint, i.e., the outcome of a choice prosess is known to him with perfect certainty. For expository reasons we start with discussing the labor supply of single individuals.

The constraints are given by

(1) $C = f(hW(z) + I)$: Budget constraint

(2) $h = H(z),\ z \in B$: Constraint on hours worked.

where $f(\cdot)$ is the function that transforms gross income to consumption, $W(z)$ is a match-specific wage rate and I is non-labor income. The function $f(\cdot)$ may be non-differentiable and even discontinuous at some points due to the tax system, social security payments, etc. (see Appendix 2, especially figures 11-14) Eq. (2) states that when z is given, hours of work is fixed and equal to $H(z)$. The set B is the set of matches that are feasible to the individual and it varies across individuals. Thus B accounts for the fact that the ability to perform respective tasks are given.

The assumption that hours of work is match-specific means that certain activities or combinations of activities require a fixed amount of time or that hours of work is determined by the firms or by the authorities.

Subject to the constraints (1) and (2) the individual's decision problem is to choose between discrete alternatives (matches) characterized by hours of work, $H(z)$, the wage rate, $W(z)$, and non-pecuniary attributes represented by a latent variable, $T(z)$. We assume that the individuals choose the alternatives that maximizes utility given the constraints and the attributes summarized in $T(z)$.

The present paper assumes that the utility function has the structure

$$(3) \qquad U(h,C,z) = v(h,C,T(z)) + \varepsilon(z)$$

where $v(.,.,.)$ is a deterministic function in the sense that for given values of h, C, and T, v is a constant. $\varepsilon(z)$ is a random term that accounts for unobserved heterogeneity in the preferences relative to z.

For the purpose of empirical implementation we have to derive densities for the observed wages and labor supply.

Now, let $G_1(w,t,h)$ be the probability that a randomly selected match, z, satisfies $(W(z)<w,\ T(z)<t,\ 0<H(z)<h)$. In other words, $G_1(w,t,h)$ is the fraction of feasible matches for which $(W(z)<w,\ T(z)<t,\ 0<H(z)<h)$. We assume that the corresponding density $g_1(w,t,h)$ exists. Furthermore, let

$$g_2(w,h) = \int g_1(w,t,h)dt$$

which is a density representing the frequency of market matches with hours h and wages w, and let

$$(4) \ \exp(\phi(h,C,w)) = E\left[\exp(v(h,C,T(z)))\,|\,H(z) = h, W(z) = w\right]$$

$$= \int \exp(v(h,C,t)) \frac{g_1(w,t,h)}{g_2(w,h)} dt$$

which is defined for $h>0$ and for $h\in K$ where K is the set of feasible hours. In eq.(4) the unobserved non-pecuniary attributes of jobs are integrated out. ϕ can be interpreted as a mean utility function derived from the distribution of individual utilities across all matches, conditional on $H(z)=h$ and $W(z)=w$.

In addition to (1) and (2) assume that

(i) the utilities are stochastically independent and identically distributed across matches,

(ii) the individual selects the optimal match according to the Luce-axiom: "independence from irrelevant alternatives".

Under these assumptions we get the following probability of working h hours, given that $h>0$ and given the wage w (see Dagsvik and Strøm (1988) for further details).

$$(5) \qquad \phi(h,K|w) = \frac{\exp(\psi(h,C(h),w))g_2(w,h)}{\int\limits_{\substack{x>0\\x\in K}} \exp(\psi(x,C(x),w))g_2(w,x)dx}$$

where $C(x) = f(wx+I)$.

Next, we assume that $W(z)$ and $H(z)$ are independent, i.e.,

$$g_2(w,h) = g_3(h)g_4(w).$$

Then (5) reduces to

$$(6) \qquad \phi\ (h,K|w) = \frac{\exp\ \phi(h,C(h),w))g_3(h)}{\int\limits_{\substack{x>0\\x\in K}} \exp\ \phi(x,C(x),w))g_3(x)} \cdot$$

The extension to the married couple case is straightforward. The joint utility function replacing (3) is

$$(7) \qquad U(h_M,h_F,C,z_M,z_F) = v(h_M,h_F,C,T(z_M,z_F))+\varepsilon(z_M,z_F)$$

where (h_j,z_j) are hours and matches for sex j. C is household consumption, i.e.,

$$(8) \qquad C = f(w_M h_M,\ w_F h_F,\ I),$$

and where now $f(\cdot)$ represents the function that transforms household income to household consumption.

The analogue to (6) is

$$(9)\ \phi(h_M,h_F,K|w_M,w_F)=\frac{\exp(\psi(h_M,h_F,f(w_Mh_M,w_Fh_F,I)))g_{3M}(h_M)g_{3F}(h_F)}{\underset{\substack{x_j>0\\ x_j\in K}}{\iint} \exp(\psi(x_M,x_F,f(w_M x_M,w_Fx_F,I)))g_{3M}(x_M)g_{3F}(x_F)dx_Mdx_F}.$$

As in (4) ψ may in general depend on (w_F, w_M) in addition to hours and consumption but this is suppressed here.

ψ and g_{3j} are parametrized by socioeconomic characteristics while the budget set represented by the function f in (9) follows from the tax rules. These rules are explained in detail in Appendix 2.

The ψ-function applied is a second order approximation to the true function and it is specified as follows:

$$\begin{aligned}(10)\ \psi(h_M,h_F,C) = {} & \alpha_1C+\alpha_2C^2+\alpha_3L_F^2+\alpha_4L_F+\alpha_5(\log A_F)L_F+\alpha_6(\log A_F)^2L_F\\ & +\alpha_7L_ML_F+\alpha_8BU6L_F+\alpha_9B717L_F+\alpha_{10}L_M^2+\alpha_{11}L_M\\ & +\alpha_{12}(\log A_M)L_M+\alpha_{13}(\log A_M)^2L_M+\alpha_{14}BU6L_M+\alpha_{15}B717L_M\\ & +\alpha_{16}A191L_M+\alpha_{17}A191L_F+\alpha_{18}A18L_M+\alpha_{19}A18L_F\end{aligned}$$

where C is household consumption, L_j is leisure time of sex j, defined as $L_j = 8760-h_j$, A_j is age, BU6 is number of children 6 years or less, B717 is number of children between 7 and 17, and j=M(ale), F(emale). Moreover,

$$A191 = \begin{cases} 1 & \text{if at least one in the household owns the home}\\ 0 & \text{otherwise}\end{cases}$$

$$A18 = \begin{cases} 1 & \text{if living in a metropolitan area (Stockholm, Gothenburg, Malmö)}\\ 0 & \text{otherwise}\end{cases},$$

Furthermore, the densities g_{3j} are specified as follows:

$$(11)\quad g_{3F}(h_F) = d_F\exp[(h_F-\bar{h}_F)^2a_F+b_{F1}D_1(h_F)+b_{F2}D_2(h_F)+b_{F3}D_3(h_F) + b_{F4}A13h_F],$$

$$(12)\quad g_{3M}(h_M) = d_M\exp[(h_M-\bar{h}_M)^2a_M+b_{M1}D_1(h_M) + b_{M4}A13h_M],$$

$a_j, d_j, b_{j1}, b_{j2}, b_{F3}$, b_{F4} and $\bar{h}_j$ are all unknown coefficients,

$$A13 = \begin{cases} 1 \text{ if member in 'white-collar' unions} \\ 0 \quad \text{otherwise} , \end{cases}$$

$$D_1(h_j) = \begin{cases} 1 \text{ if } h_j \in [2040,\ 2120] \\ 0 \quad \text{otherwise} , \end{cases}$$

$j = M, F,$

$$D_2(h_F) = \begin{cases} 1 \text{ if } h_F \in [1520, 1600] \\ 0 \quad \text{otherwise} , \end{cases}$$

$$D_3(h_F) = \begin{cases} 1 \text{ if } h_F \in [1000, 1080] \\ 0 \quad \text{otherwise} . \end{cases}$$

The interval [2040,2120], which is equivalent to around 40 hours per week, covers the range of hours in full time jobs while the two other intervals cover the range of hours in part time jobs, 30 hours per week and 20 hours per week, respectively.

Let

$$(13) \quad \psi^*(h_M, h_F, w_M, w_F) = \psi(h_M, h_F, f(w_M h_M, w_F h_F, I)) + \sum_{j=F,M} [\log d_j + a_j (h_j - \bar{h}_j)^2 + b_{j4} A_{13} h_j + b_{1j} D_1(h_j)] + \sum_{i=2}^{3} b_{Fi} D_i(h_F)$$

and observe that (9) can be expressed by $\psi^*(\cdot)$. From (10) and (13) it is evident that the latent rationing of hours cannot be disentangled from preferences. However, if we keep the rationing densities $g_{3j}(\cdot)$ fixed we are able to perform simulation experiments.

3. Data.

The sources of the data set, together with the description of the tax rules, are set out in two appendices. Here it suffices to give some summary statistics of the sample for the most important variables appearing in the model.

Data contains socioeconomic information about married couples in Sweden in 1981. Age of the wife is restricted to be between 27 and 64 and self-employed are excluded from the sample. Moreover, observations in each tail of the wage distribution is selected out. (Those with reported wage below 10 SWkr and above 170 Swkr are excluded.) The data set includes 1649 observations of married couples.

Table 1 gives the summary statistics and figures 1 and 2 give the frequencies of hours worked by males and females, respectively. We observe the extreme concentration around full time and part time jobs. This may partly be due to measurement error since annual hours of work is obtained by multiplying reported hours a week by number of weeks.

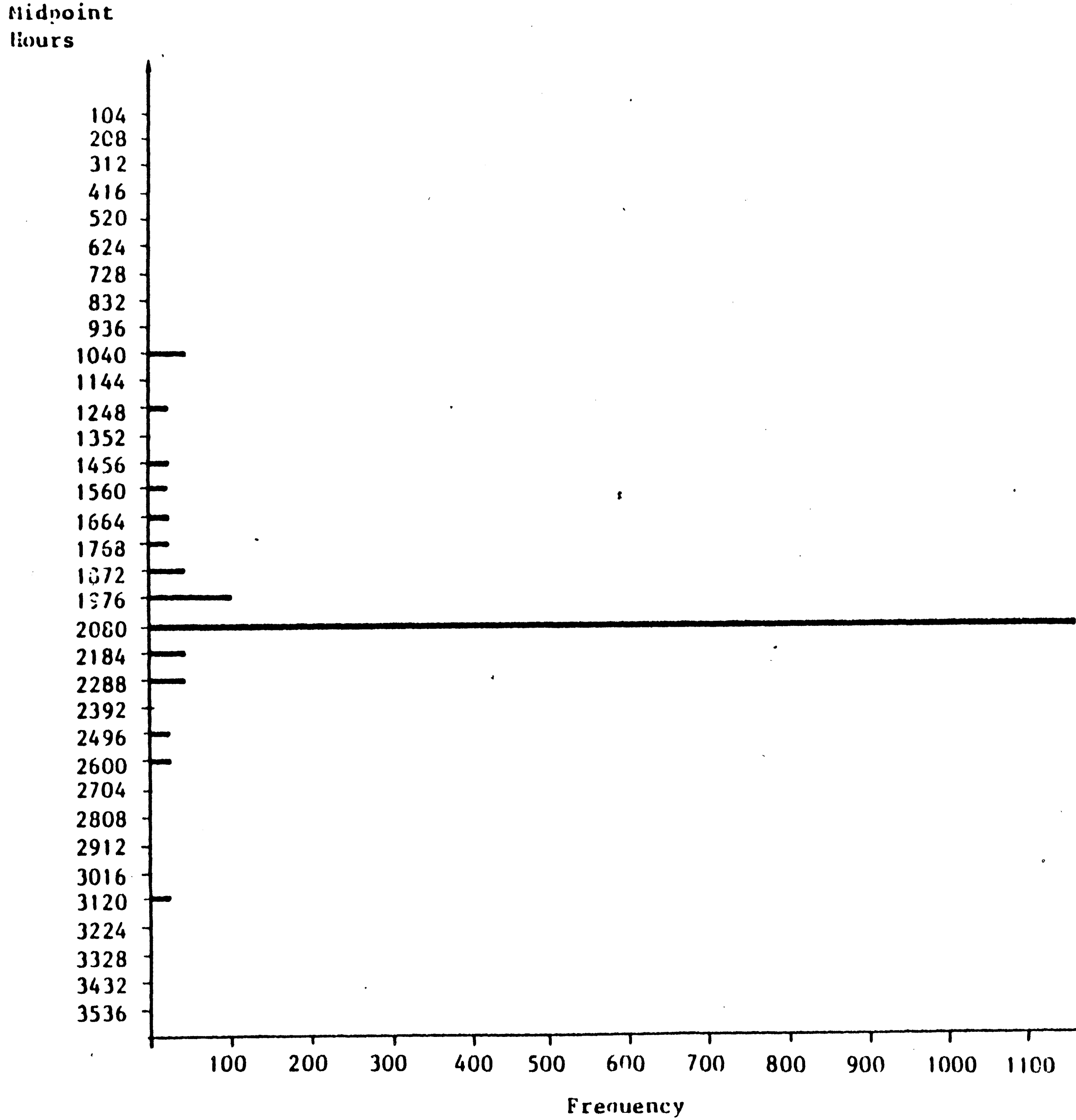
In figures 3-6 we give the observed frequencies of observed wages and marginal tax rates.

Table 1. Summary statistics for 1649 married couple, Sweden 1981.

Variables	Mean	Stand.dev.	Min.value	Max.value	Units
Hours worked by males	2021.26	327.86	240	3484	hours a year
Hours worked by females	1542.69	516.58	120	3286	"
Fulltime fraction males	0.69	0.46	0	1.0	-
Fulltime fraction females	0.30	0.46	0	1.0	-
Part-time, 30h/week, females	0.11	0.32	0	1.0	-
Part-time, 20h/week, female	0.16	0.37	0	1.0	-
Hourly wage rate males	54.88	21.92	11.40	163.30	SEK/hour
Hourly wage rate females	41.64	14.72	11.23	167.10	"
Gross earnings males 1)	109512	47264	0	639200	SEK a year
Gross earnings, females 1)	63088	26695	16800	254600	"
Marginal tax rate, males	0.63	0.14	0.22	0.85	-
Marginal tax rate, females	0.47	0.14	0	0.88	-
Net taxes paid by households	60465	34786	2924	407096	SEK a year
Household consumption	116849	29557	31224	310654	"
Number of children below 7	0.38	0.65	0	3.0	-
Number of children between 7,17	0.80	0.92	0	7.0	-
Age, males	43.48	9.76	22.0	64.0	Years
Age, females	41.06	9.33	27.0	63.0	"
Own-house fraction	0.63	0.48	0	1.0	-
Metropolitan fraction	0.71	0.46	0	1.0	-

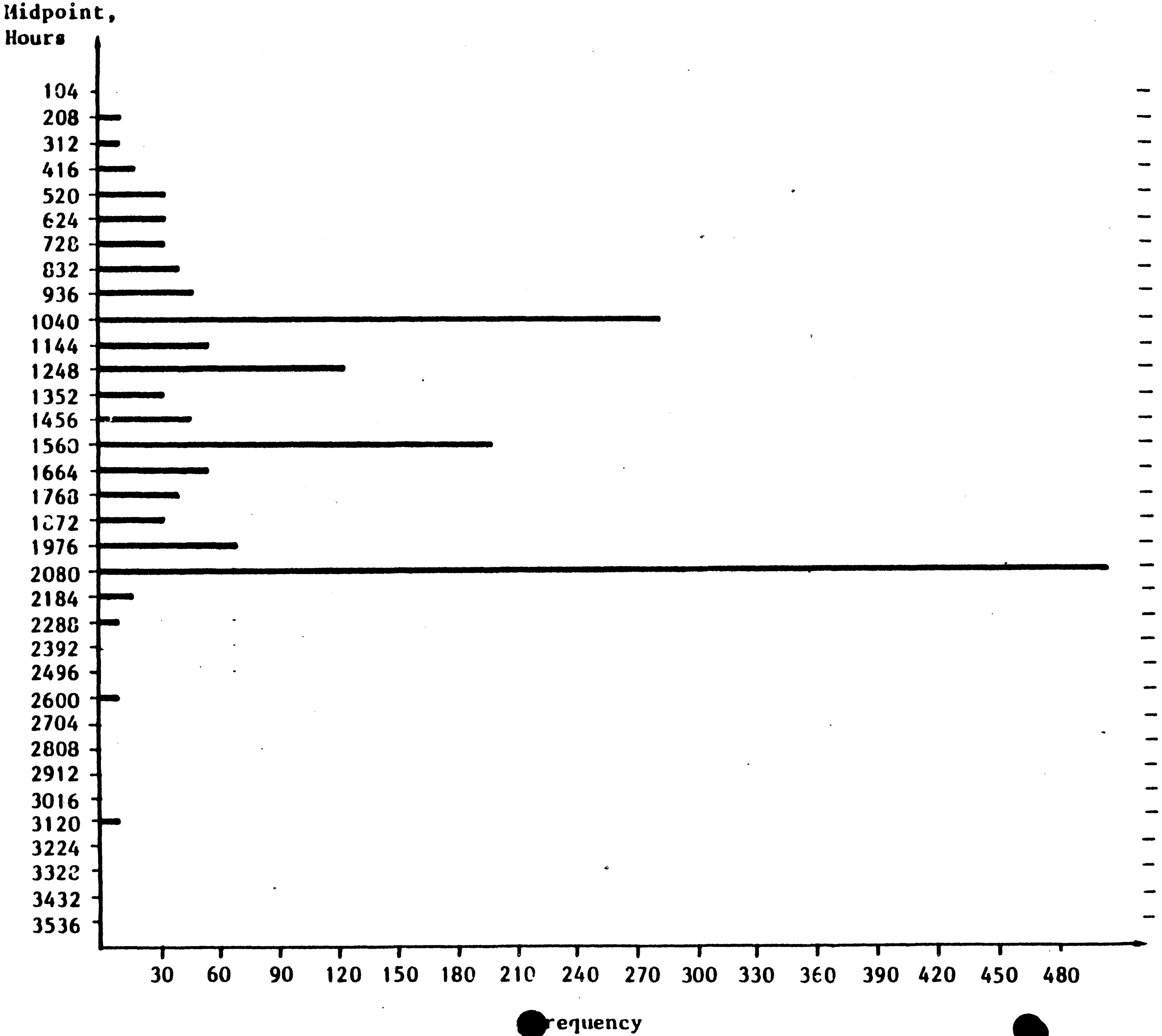
1) Gross earnings are defined as gross wage income after the deduction of expences on items needed in the job which are tax deductible.

Figure 1. Observed frequencies of hours worked by Swedish males, 1981



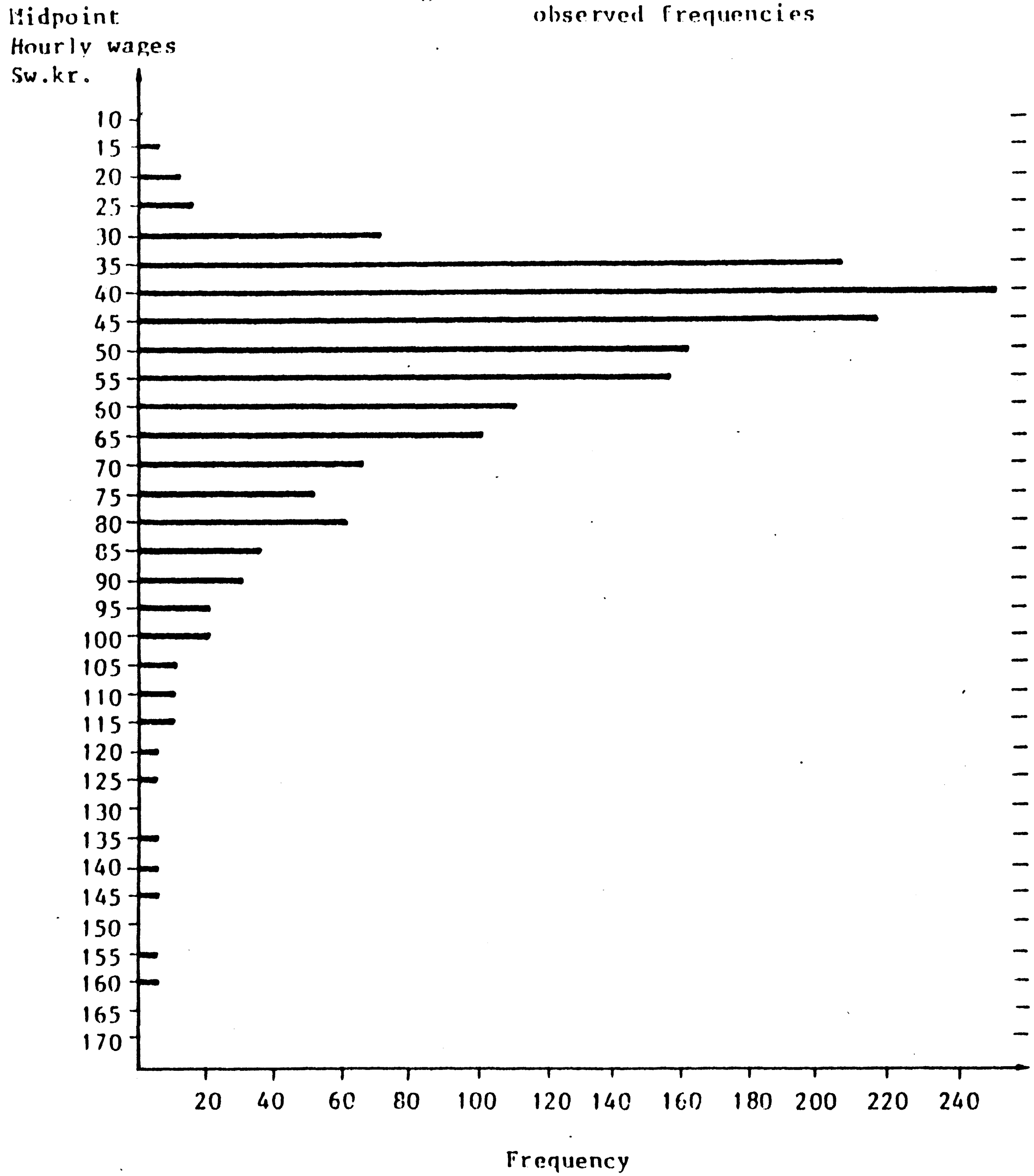
Midpoint Hours	Freq	Cum. freq	Percent	Cum. percent
104	0	0	0.00	0.00
208	2	2	0.12	0.12
312	2	4	0.12	0.24
416	0	4	0.00	0.24
520	7	11	0.42	0.67
624	2	13	0.12	0.79
728	8	21	0.49	1.27
832	3	24	0.18	1.46
936	6	30	0.36	1.82
1040	37	67	2.24	4.06
1144	7	74	0.42	4.49
1248	22	96	1.33	5.82
1352	8	104	0.49	6.31
1456	10	114	0.61	6.91
1560	28	142	1.70	8.61
1664	17	159	1.03	9.64
1768	23	182	1.39	11.04
1872	43	225	2.61	13.64
1976	102	327	6.19	19.83
2080	1165	1492	70.65	90.48
2184	38	1530	2.30	92.78
2288	49	1579	2.97	95.76
2392	5	1584	0.30	96.06
2496	10	1594	0.61	96.66
2600	27	1621	1.64	98.30
2704	3	1624	0.18	98.48
2808	9	1633	0.55	99.03
2912	2	1635	0.12	99.15
3016	0	1635	0.00	99.15
3120	11	1646	0.67	99.82
3224	0	1646	0.00	99.82
3328	2	1648	0.12	99.94
3432	1	1649	0.06	100.00
3536	0	1649	0.00	100.00

Figure 2. Observed frequencies of hours worked by Swedish females, 1981.



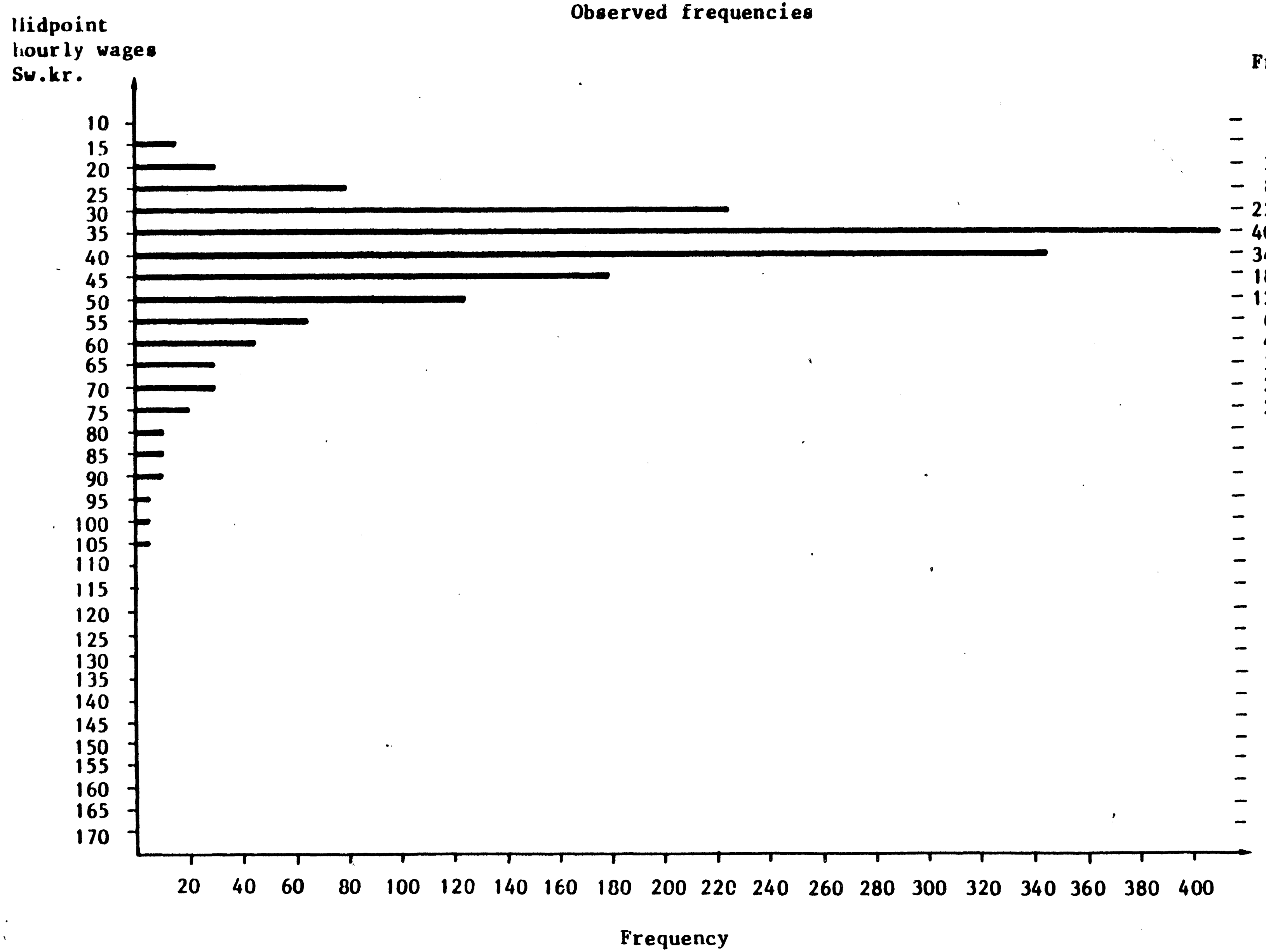
Freq	Cum. freq	Percent	Cum. percent
1	1	0.06	0.06
4	5	0.24	0.30
6	11	0.36	0.67
13	24	0.79	1.46
33	57	2.00	3.46
30	87	1.82	5.28
33	120	2.00	7.28
39	159	2.37	9.64
46	205	2.79	12.43
274	479	16.62	29.05
52	531	3.15	32.20
119	650	7.22	39.42
30	680	1.82	41.24
46	726	2.79	44.03
195	921	11.83	55.85
49	970	2.97	58.82
39	1009	2.37	61.19
31	1040	1.88	63.07
70	1110	4.24	67.31
501	1611	30.38	97.70
14	1625	0.85	98.54
8	1633	0.49	99.03
2	1635	0.12	99.15
2	1637	0.12	99.27
4	1641	0.24	99.51
2	1643	0.12	99.64
1	1644	0.06	99.70
0	1644	0.00	99.70
0	1644	0.00	99.70
4	1648	0.24	99.94
0	1648	0.00	99.94
1	1649	0.06	100.00
0	1649	0.00	100.00
0	1649	0.00	100.00

Figure 3. Male wage rates in Sweden 1981, observed frequencies



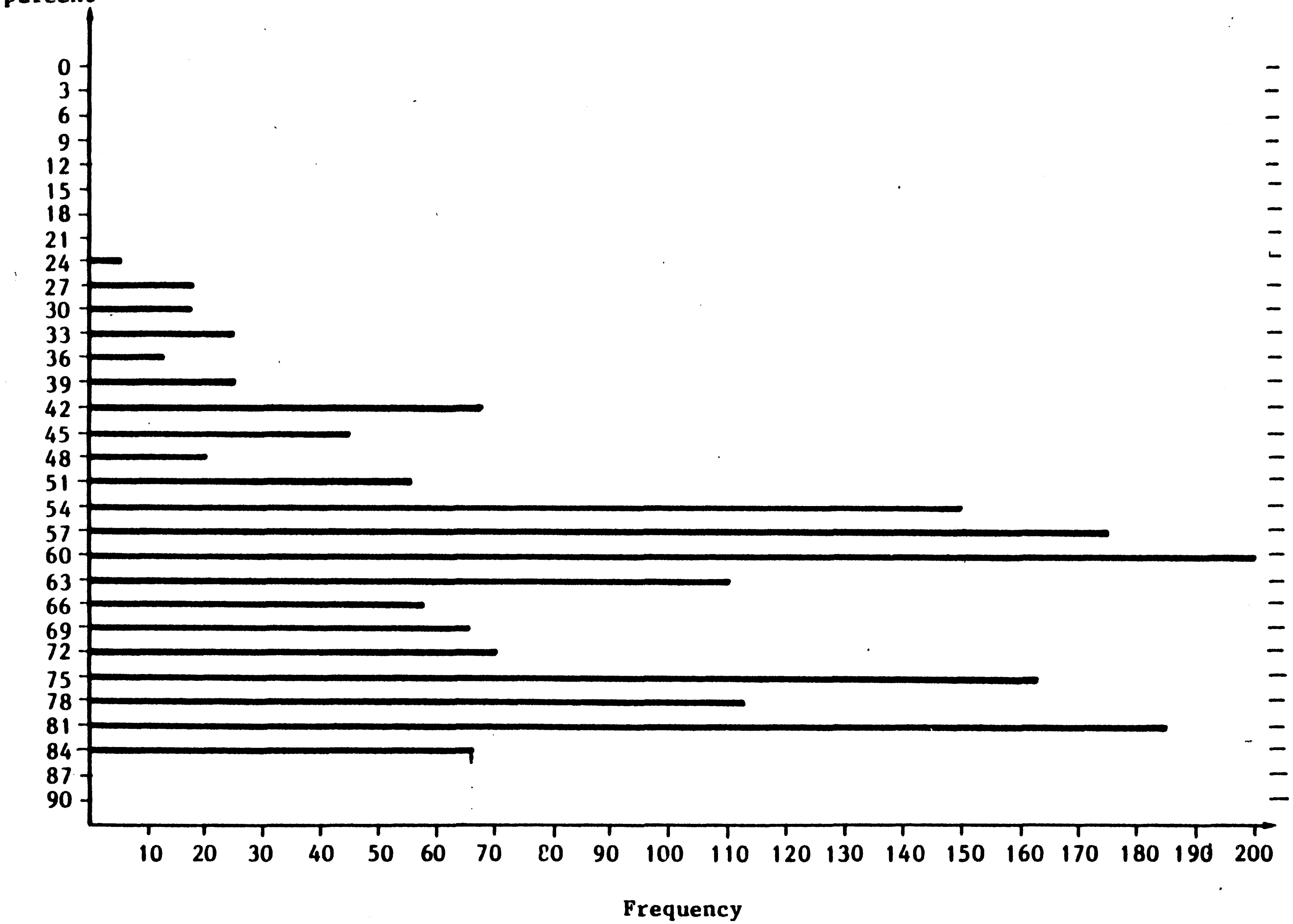
Midpoint	Freq	Cum. freq	Percent	Cum. percent
10	1	1	0.06	0.06
15	6	7	0.36	0.42
20	9	16	0.55	0.97
25	14	30	0.85	1.82
30	72	102	4.37	6.19
35	203	305	12.31	18.50
40	252	557	15.28	33.78
45	217	774	13.16	46.94
50	159	933	9.64	56.58
55	155	1088	9.40	65.98
60	110	1198	6.67	72.65
65	102	1300	6.19	78.84
70	67	1367	4.06	82.90
75	51	1418	3.09	85.99
80	61	1479	3.70	89.69
85	37	1516	2.24	91.93
90	29	1545	1.76	93.69
95	22	1567	1.33	95.03
100	21	1588	1.27	96.30
105	11	1599	0.67	96.97
110	8	1607	0.49	97.45
115	9	1616	0.55	98.00
120	7	1623	0.42	98.42
125	5	1628	0.30	98.73
130	2	1630	0.12	98.85
135	4	1634	0.24	99.09
140	3	1637	0.18	99.27
145	3	1640	0.18	99.45
150	1	1641	0.06	99.51
155	3	1644	0.18	99.70
160	3	1647	0.18	99.88
165	2	1649	0.12	100.00
170	0	1649	0.00	100.00

Figure 4. Female wage rates, Sweden 1981
Observed frequencies



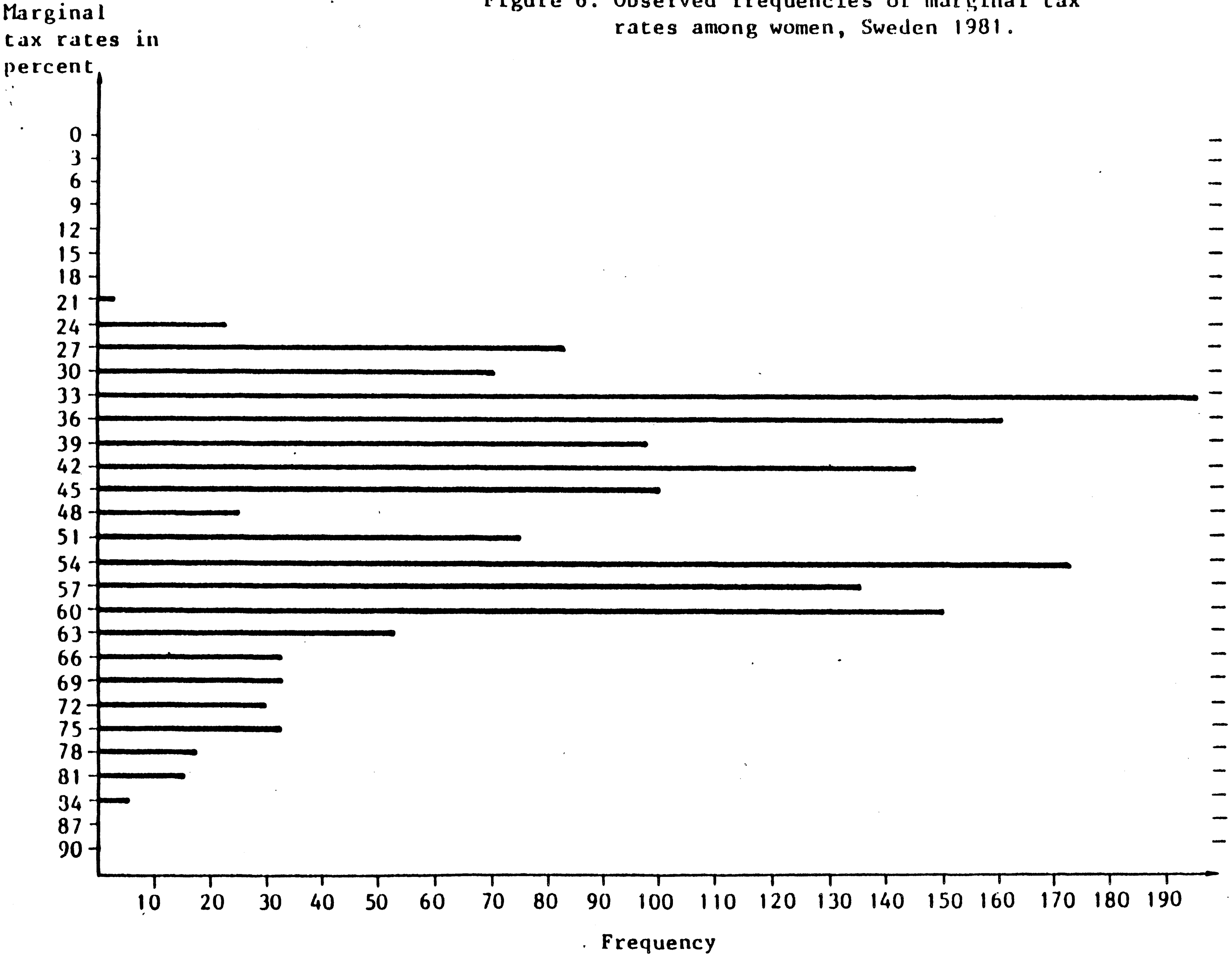
Midpoint hourly wages Sw.kr.	Freq	Cum. freq	Percent	Cum. percent
10	1	1	0.06	0.06
15	15	16	0.91	0.97
20	30	46	1.82	2.79
25	81	127	4.91	7.70
30	223	350	13.52	21.22
35	409	759	24.80	46.03
40	343	1102	20.80	66.83
45	182	1284	11.04	77.87
50	125	1409	7.58	85.45
55	65	1474	3.94	89.39
60	45	1519	2.73	92.12
65	30	1549	1.82	93.94
70	29	1578	1.76	95.69
75	22	1600	1.33	97.03
80	10	1610	0.61	97.63
85	8	1618	0.49	98.12
90	12	1630	0.73	98.85
95	4	1634	0.24	99.09
100	3	1637	0.18	99.27
105	4	1641	0.24	99.51
110	2	1643	0.12	99.64
115	1	1644	0.06	99.70
120	0	1644	0.00	99.70
125	2	1646	0.12	99.82
130	0	1646	0.00	99.82
135	1	1647	0.06	99.88
140	0	1647	0.00	99.88
145	0	1647	0.00	99.88
150	0	1647	0.00	99.88
155	1	1648	0.06	99.94
160	0	1648	0.00	99.94
165	1	1649	0.06	100.00
170	0	1649	0.00	100.00

Figure 5. Observed frequencies of marginal tax rates among men, Sweden 1981.



Freq	Cum. freq	Percent	Cum. percent
0	0	0.00	0.00
0	0	0.00	0.00
0	0	0.00	0.00
0	0	0.00	0.00
0	0	0.00	0.00
0	0	0.00	0.00
0	0	0.00	0.00
1	1	0.06	0.06
4	5	0.24	0.30
18	23	1.09	1.39
17	40	1.03	2.43
26	66	1.58	4.00
13	79	0.79	4.79
26	105	1.58	6.37
68	173	4.12	10.49
46	219	2.79	13.28
21	240	1.27	14.55
54	294	3.27	17.83
151	445	9.16	26.99
176	621	10.67	37.66
201	822	12.19	49.85
110	932	6.67	56.52
57	989	3.46	59.98
66	1055	4.00	63.98
69	1124	4.18	68.16
163	1287	9.88	78.05
113	1400	6.85	84.90
185	1585	11.22	96.12
64	1649	3.88	100.00
0	1649	0.00	100.00
0	1649	0.00	100.00

Figure 6. Observed frequencies of marginal tax rates among women, Sweden 1981.



	Freq	Cum. freq	Percent	Cum. percent
0	1	1	0.06	0.06
3	0	1	0.00	0.06
6	0	1	0.00	0.06
9	0	1	0.00	0.06
12	0	1	0.00	0.06
15	0	1	0.00	0.06
18	0	1	0.00	0.06
21	2	3	0.12	0.18
24	23	26	1.39	1.58
27	83	109	5.03	6.61
30	70	179	4.24	10.86
33	196	375	11.89	22.74
36	161	536	9.76	32.50
39	97	633	5.88	38.39
42	144	777	8.73	47.12
45	100	877	6.06	53.18
48	26	903	1.58	54.76
51	75	978	4.55	59.31
54	172	1150	10.43	69.74
57	134	1284	8.13	77.87
60	149	1433	9.04	86.90
63	52	1485	3.15	90.05
66	33	1518	2.00	92.06
69	33	1551	2.00	94.06
72	29	1580	1.76	95.82
75	32	1612	1.94	97.76
78	17	1629	1.03	98.79
81	15	1644	0.91	99.70
84	4	1648	0.24	99.94
87	1	1649	0.06	100.00
90	0	1649	0.00	100.00

5. Estimation results

The estimation of the model is based on a procedure suggested by McFadden (1981) 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 (9) would be to costly and cumbersome. The procedure applied goes as follows. In addition to the observed hours of work we make 140 draws of hours for each spouse from an uniform distribution over the interval [60, 3600]. These draws are used to evaluate the denominator in (9). The unknown coefficients in the labor supply distribution are estimated in a modified maximum likelihood procedure. According to McFadden (1981) these estimates are consistent and asymptotically normal.

Table 2 gives the estimates of the unknown coefficients together with asymptotic t-values.

Table 2. Estimates of the parameters of the labor supply model for, married Swedish couples, 1981.

Variables	Estimates	t-values
$10^{-4}C$	1.1471	5.99
$10^{-9}C^2$	-0.2831	-5.92
$10^{-6}L_F^2$	-1.5603	-13.22
$10^{-2}L_F$	6.5778	3.50
$10^{-2}(\log A_F)L_F$	-2.4748	-2.46
$10^{-2}(\log A_F)^2L_F$	0.3403	2.50
$10^{-6}L_ML_F$	0.1883	1.18
10^{-3}BU6 L_F	0.4876	4.02
10^{-3}B717 L_F	0.2018	2.58
$10^{-6}L_M^2$	-1.5223	-11.17
$10^{-2}L_M$	10.4869	5.02
$10^{-2}(\log A_M)L_M$	-4.6701	-4.25
$10^{-2}(\log A_M)^2L_M$	0.6358	4.31
10^{-3} BU6 L_M	-0.0673	-0.42
10^{-3}B717 L_M	-0.1927	-1.82
10^{-3}A191 L_M	-0.4920	-2.67
10^{-3}A191 L_F	0.1378	0.99
10^{-3}A18 L_M	-0.2250	-1.24
10^{-3}A18 L_F	-0.3373	-2.52
$10\ D_1(h_M)$	0.3450	47.49
$10\ D_1(h_F)$	0.2927	30.04
$10\ D_2(h_F)$	0.1417	13.12
$10\ D_3(h_F)$	0.1734	17.63
10^{-3}A13 L_M	-0.8114	-4.44
10^{-3}A13 L_F	-0.9364	-6.95

All the estimates have the expected sign and most of the coefficients are significantly different from zero with the cross leisure term as a noteworthy exception. The estimates imply that the 'mean utility' function (ψ^*) is strictly concave in consumption and leisure. The model allows the marginal 'utility' of leisure (marginal of ψ^*) to be negative even at the point of adjustment which might be due to constraints on hours. This event occurs for some of the individuals in the sample, but in most cases the marginal 'utility' of leisure is positive. It is a convex function of age with a minimum at 37.9 years of age and 39.4 for females and males, respectively.

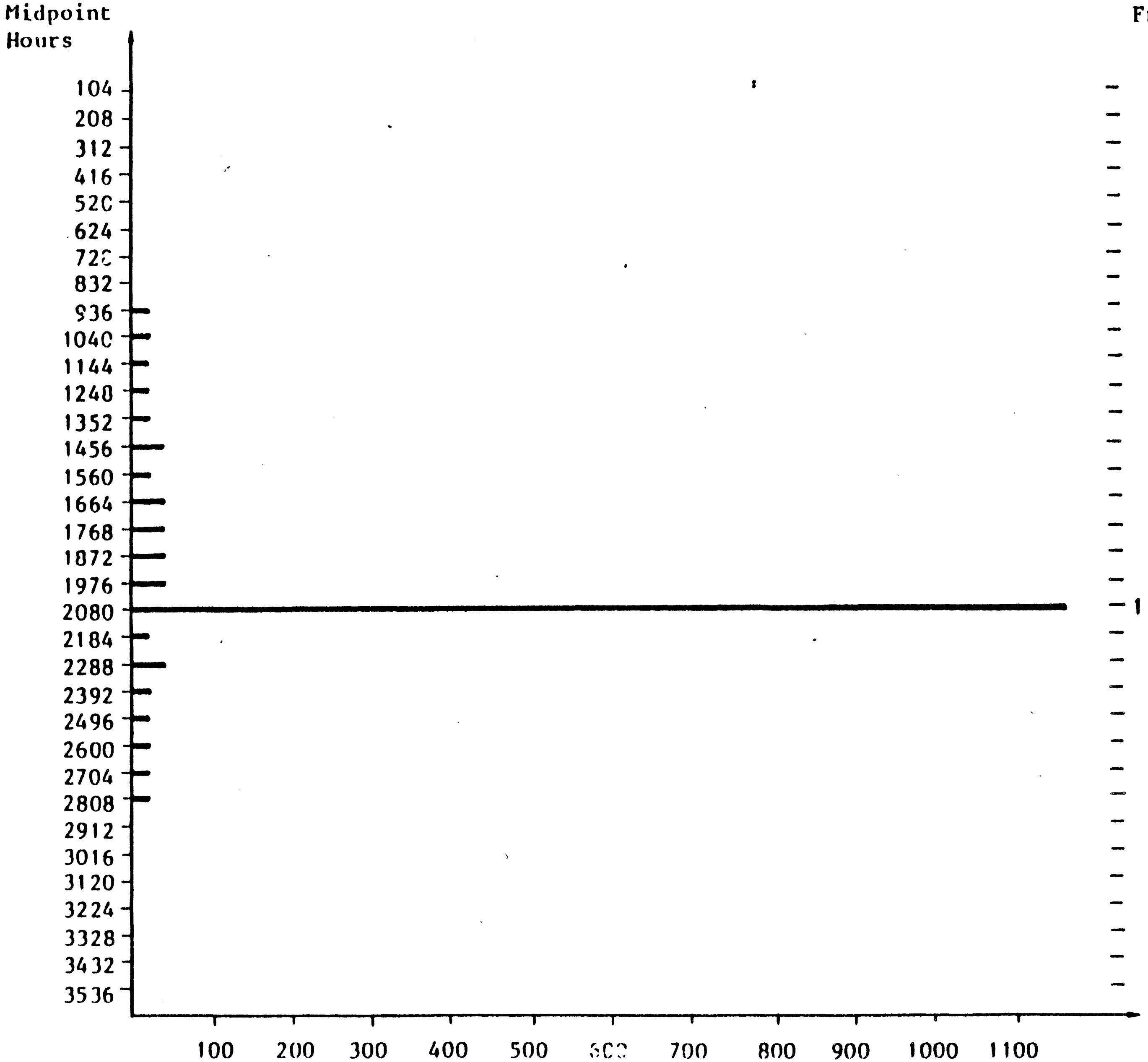
The more children the couple has, especially below 6 years of age, the less inclined the wife is to supply labor in the market. Males labor supply is not significantly affected.

Ownership to the couples home has a positive impact on the labor supply of the husband, most likely because of rationing in the credit market.

The lack of suitable job opportunities in rural areas is probably the reason why female labor supply is negatively affected when living in these areas. Figure 7 and 8 give the predicted hours of work distribution for

males and females, respectively. The estimated model gives a fairly good prediction of observed frequencies of hours worked (compare figures 1-2 and figures 7-8).

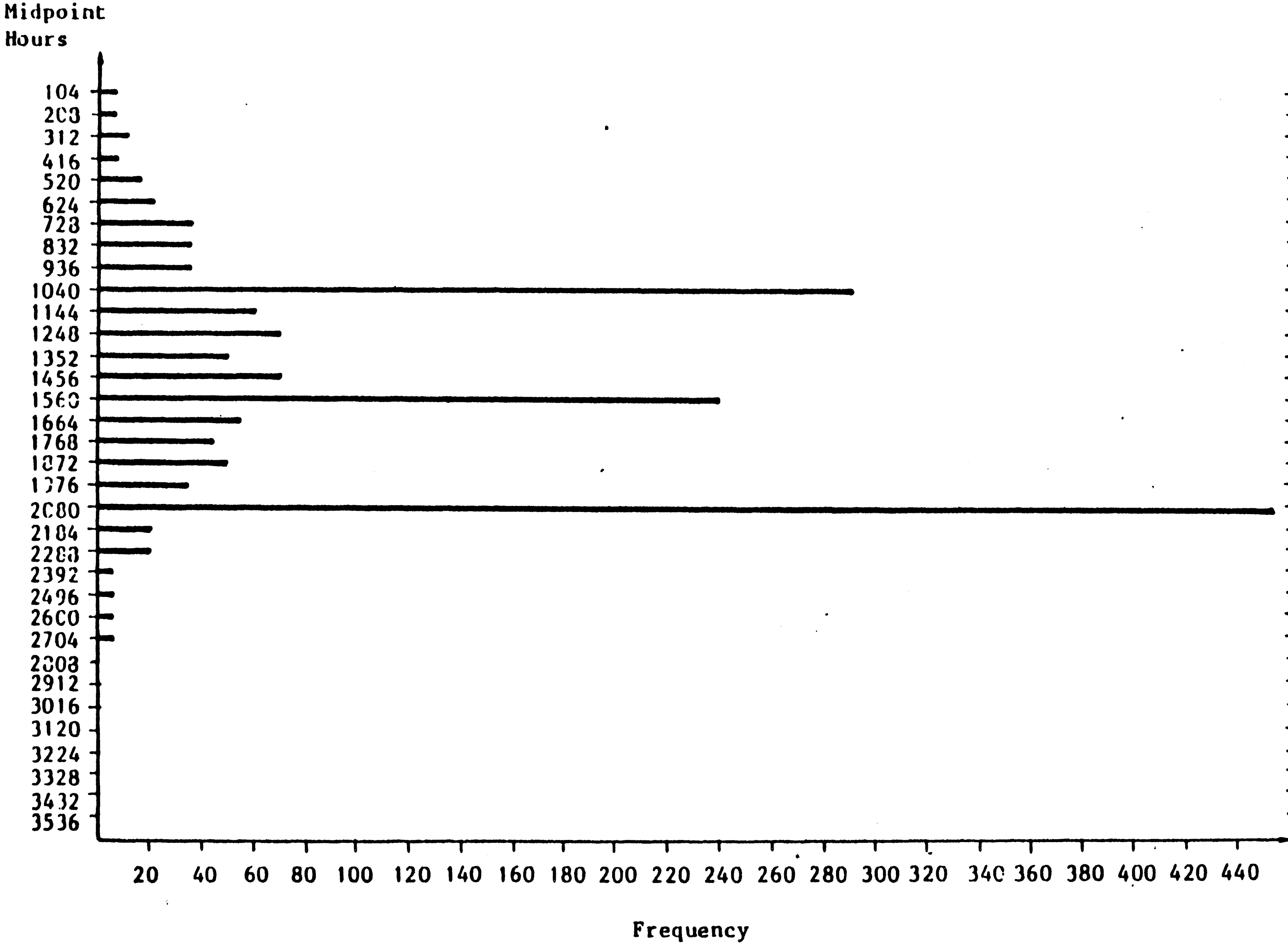
Figure 7. Hours worked by males, predicted frequencies.



Midpoint Hours	Freq	Cum. freq	Percent	Cum. percent
104	0	0	0.00	0.00
208	0	0	0.00	0.00
312	0	0	0.00	0.00
416	1	1	0.06	0.06
520	2	3	0.12	0.18
624	2	5	0.12	0.30
728	4	9	0.24	0.55
832	4	13	0.24	0.79
936	14	27	0.85	1.64
1040	10	37	0.61	2.24
1144	14	51	0.85	3.09
1248	19	70	1.15	4.24
1352	24	94	1.46	5.70
1456	30	124	1.82	7.52
1560	26	150	1.58	9.10
1664	41	191	2.49	11.58
1768	44	235	2.67	14.25
1872	45	280	2.73	16.98
1976	47	327	2.85	19.83
2080	1156	1438	70.10	89.93
2184	29	1512	1.76	91.69
2288	32	1544	1.94	93.63
2392	23	1567	1.39	95.03
2496	13	1580	0.79	95.82
2600	25	1605	1.52	97.33
2704	12	1617	0.73	98.06
2808	10	1627	0.61	98.67
2912	7	1634	0.42	99.09
3016	9	1643	0.55	99.64
3120	3	1646	0.18	99.82
3224	1	1647	0.06	99.88
3328	1	1648	0.06	99.94
3432	1	1649	0.06	100.00
3536	0	1649	0.00	100.00

Frequency

Figure 8. Hours worked by females, predicted frequencies.



Midpoint Hours	Freq	Cum. freq	Percent	Cum. percent
104	5	5	0.30	0.30
208	5	10	0.30	0.61
312	8	18	0.49	1.09
416	6	24	0.36	1.46
520	17	41	1.03	2.49
624	20	61	1.21	3.70
728	34	95	2.06	5.76
832	35	130	2.12	7.88
936	37	167	2.24	10.13
1040	292	459	17.71	27.84
1144	62	521	3.76	31.59
1248	68	589	4.12	35.72
1352	49	638	2.97	38.69
1456	68	706	4.12	42.81
1560	242	948	14.68	57.49
1664	53	1001	3.21	60.70
1768	45	1046	2.73	63.43
1872	50	1096	3.03	66.46
1976	34	1130	2.06	68.53
2080	457	1587	27.71	96.24
2184	22	1609	1.33	97.57
2288	18	1627	1.09	98.67
2392	6	1633	0.36	99.03
2496	3	1636	0.18	99.21
2600	6	1642	0.36	99.58
2704	6	1648	0.36	99.94
2808	1	1649	0.06	100.00
2912	0	1649	0.00	100.00
3016	0	1649	0.00	100.00
3120	0	1649	0.00	100.00
3224	0	1649	0.00	100.00
3328	0	1649	0.00	100.00
3432	0	1649	0.00	100.00
3536	0	1649	0.00	100.00

5. Wage elasticities and policy simulation

5.1. Mean utility elasticities

In previous studies of labor supply the error terms are typically assumed independent of hours and consumption. This makes it possible to calculate individual wage elasticities. In our model this is not so because the error term depends on the optimal match which in turn depends on hours worked.

The conditional expected utility, ϕ, defined in (4) and evaluated for mean sample values, is the utility concept that comes closest to the one used by others in the calculation of elasticities.

However, the likelihood function is a mixture of ϕ and the densities, g_{3j}. We are not able to separate ϕ from g_{3j} without introducing further assumptions. But if a shift in an exogeneous variable does not change the 'rationing' densities, then elasticities calculated on the basis of ϕ^* is equivalent to elasticities calculated from ϕ.

With these reservations in mind we have calculated mean utility-mean sample elasticities, given that he or she works, on the basis of the following set of equations:

$$(14) \qquad C = \sum_j m_j h_j + \hat{I} ,$$

$$(15) \qquad \frac{\partial\phi^*(\cdot)}{\partial L_M} - \frac{\partial\phi^*(\cdot)}{\partial C} \cdot m_M = 0 ,$$

$$(16) \qquad \frac{\partial\phi^*(\cdot)}{\partial L_M} - \frac{\partial\phi^*(\cdot)}{\partial C} \cdot m_F = 0 ,$$

where $m_j = w_j(1-S_j')$ = marginal wage rate; j=H,F,

$\hat{I} = I(1-S_M') + \sum_j d_{jb}$ = virtual income, and $d_{jb} = \sum_{k=1}^{jb} t_k \bar{R}_k - \sum_{k=1}^{jb} t_k \bar{R}_{k-1}$.

$\bar{R}_k - \bar{R}_{k-1}$ denotes the size of the tax-bracket k measured in SEK. t_k is the marginal tax rate on tax segment k. jb is the optimal tax bracket for the representative individual.

The elasticities are denoted mean utility elasticities and the following ones are shown in table 3:

- uncompensated elasticities, hours h_j with respect to w_j (Cournot elasticities)
- compensated or utility constant elasticities (Slutsky)
- total income elasticities (Cournot minus Slutsky)
- consumption constant elasticities (Frisch elasticities).

Table 3. Mean utility wage and income elasticities calculated at mean sample values of the variables. Sweden 1981.

Type of elasticity	Males		Females	
	Own	Cross	Own	Cross
Cournot	0.08	−0.07	0.13	−0.11
Slutsky	0.46	−0.01	0.22	−0.04
Total income	−0.38	-	−0.09	-
Frisch	0.16	0.01	0.16	0.01

The direct Cournot elasticities are numerically low which is in accordance with the conventional wisdom in Scandinavian countries. The estimate of the male elasticity is even identical to the estimate reported in Blomquist (1983) and elasticities do not deviate very much from estimates obtained by applying the same model to Norwegian data from 1979; with one exception, the female own wage elasticity are substantially higher in the Norwegian case, see Dagsvik and Strøm (1988). There are some obvious reasons why, Swedish women work on the average longer hours than in Norway. Moreover, in the Swedish tax system married couples are taxed separately while joint taxation is optional in Norway. From a socio-economic point of view one should therefore expect Swedish women to have labor supply behavior more like Norwegian men and this is actually what our study confirms. However, the Norwegian study is not immediately comparable since in the Norwegian case annual hours of work is obtained by dividing labor earnings by the reported wage rate. As mentioned above in the Swedish case we use the reported hours worked during a 'normal week'.

Table 3 shows that while Cournot elasticities are numerically low, the Slutsky elasticities, especially for men, are numerically significant. This indicates loss in efficiency due to taxation.

We also note that the cross elasticities are numerically low which is in accordance with what we have obtained for other countries, cf. the references given above.

5.2 Aggregate elasticities

Another set of elasticities arises when we consider how the distribution of labor supply is affected by changes in say, wage levels. These elasticities are denoted aggregate elasticities since they take into account all unobserved and observed heterogeneity in the population.

Note that expected aggregate labor supply is given by:

$$H = \sum_x x\hat{\phi}(x) \tag{17}$$

where $\hat{\phi}(x)$ is the aggregate (marginal) density of hours x. $\hat{\phi}(x)$ can be obtained by summing the respective household-specific densities over all household characteristics. The aggregate elasticities shown in table 4 are derived from applying the model to calculate the impact of one per cent increase in wages on the labor supply decisions.

Table 4. Aggregate labor supply elasticities, Sweden 1981.

Type of wage changes	Male elasticities	Female elasticities
Male wage rates increased by 1 percent	-0.02	-0.05
Female wage rates increased by 1 per cent	-0.03	0.04
Both wage rates increased by 1 percent	-0.03	-0.03

By comparing the two tables we observe that the aggregate elasticities are numerically smaller than the corresponding individual Cournot elasticities. There are two reasons for this. In the first place heterogeneity may reduce the wage response on the aggregate level. Secondly, when calculating mean utility elasticities hours restriction are ignored while this is not so in the calculation of aggregate elasticities. A striking result is that except for the own female wage elasticity all elasticities are negative. The reported elasticities for men are of the same size as the elasticities reported in Ljones and Strøm (1987), but the female elasticities are substantially lower in absolute value and have opposite signs. The explanation is most likely that in Ljones and Strøm restriction on hours were not accounted for in the same explicit way as in the present study.

5.3 Policy simulations

The model has been used to simulate the outcome of 9 different policy changes. In order to perform the simulations we have divided the feasible set of hours into intervals of length 100 hours. Altogether this gives 1225 cells of hours that the couples are assumed to consider in making their optimal choice. From the extreme value distribution we then make 1225 corresponding draws to simulate realizations of the error term $\varepsilon(z_M, z_F)$ in the utility function. These draws together with the midpoint of each cell form the empirical basis for the simulations of the optimal decisions. For each simulation we report the impact on

- aggregate labor supply of hours for men, women and total
- full-time/part-time fractions
- gross earnings, male, female and total
- taxes paid by the household and household consumption.

The policy changes considered are:

I Male wage rates increased by 10 per cent

II Female wage rates increased by 10 per cent

III Both female and male wage rates increased by 10 per cent

IV Reduction in all marginal tax rates by 5 percentage points

V One child less in every household

VI Removal of hours restriction

VII Given VI; reduction in all marginal tax rates by 5 percentage points

VIII Separate taxation replaced by joint taxation.

IV As VIII, but tax revenue is kept constant.

The results are presented in table 5. The two first columns give the observed and predicted values based on the model before wage rates, tax rules, etc. are changed. All variables are expressed as average magnitudes and are defined as the sum of individual realizations divided by the total number of individuals in the sample.

The increase in wage rates has, in most cases, a <u>negative</u> impact on hours supplied. However, gross household earnings are increased by 3.62 per cent when female wage rates are increased, and by 9.5 per cent when both wage rates are increased. Taxes are increased even more so because of the progressiveness of the tax schedule. We note that a 10 per cent overall wage increase results in a 5 per cent increase in household consumption. A minor part of this difference is due to reduction in labor supply. In table 6 we have decomposed the effect of the policy changes into effects due to changes in exogenous factors and effects that are due to behavioral changes, i.e., reduction in labor supply. We observe that in most of the cases behavioral changes count for very little of the total change.

Reduction in all marginal tax rates by 5 percentage points, which implies a loss of 11.45 per cent in tax revenue, <u>stimulates</u> labor supply but only to a minor extent. Total hours supplied is calculated to increase by 0.17 per cent. The loss in tax revenue indicates that, given the present tax system in Sweden, the tax rates are still below the levels which maximize tax revenue. Consumption is stimulated far more than gross earnings which indicates an increase in imports and deterioration of the balance of payments.

"One child less" has been included to show the impact on labor supply (and other labor supply related variables) of child care. As expected female labor supply is stimulated with inter alia a shift from part-time work to full-time jobs. These changes are substantially weaker than in other European countries such as Norway, West-Germany and France, see Dagsvik and Strøm (1988), Dagsvik et al (1988) and Holst et al (1988). The most likely reason is the quite generous permission rules after birth of a child in Sweden compared with other countries. Although female labor supply is stimulated more than in the other cases discussed so far, the impact on total earnings, tax revenue and consumption is not very strong.

The impact on the hours of work densities of removing restrictions on hours is given in figures 9 and 10 and we clearly observe how drastic this change is. (In this simulation experiment we have interpreted the extreme peaks in hours distribution as the result of demand constraints). A striking result reported in table 5 is that hours supplied are reduced, particularly among females. It seems that introducing a "free choice" of hours will reduce labor supply, earnings and consumption. Due to the preserved progressiveness of the tax schedule tax revenue drops by more than the reduction in total earnings. A tempting conclusion is that hours restrictions imposed on Swedish workers have forced them to work longer hours on the average than they prefer. When taxes are cut, given the removal of hours restrictions, the labor supply becomes slightly more elastic than in the case of tax cuts in a regulated economy.

In contrast to most other countries Swedish couples are taxed separately, that is, wage incomes are taxed separately while capital incomes are jointly taxed. To simulate the impact on labor supply of joint taxation of all sorts of income we have applied the joint taxation schedule for capital income on wage income as well. The results of this simulation are shown in the last columns of table 5 and we observe that the effect on labor supply is strong with an expected decrease in female labor supply. Also tax rates for males are increased but to a smaller extent than for women. Male labor supply is therefore reduced. Higher tax rates implied by this shift of tax rules show up in higher tax revenue which is increased by as much as 30 per cent.

In the last column we report the outcome of a tax neutral shift of tax rules when separate taxation is replaced by joint taxation. All marginal tax rates are reduced proportionally to get revenue down to the initial level. The needed cut is 22 per cent. Female labor supply is still substantial lower than in the base case (-3.36 per cent lower), but the males working hours are almost brought back to initial levels. Of course, there are many factors that contribute to the low female labor supply relative to males in countries with joint taxation, but the simulations performed here show that tax rules might play an important role in the explanation of labor market behavior.

Table 5. Policy simulations, Sweden 1981

Variables	Observed values	Base predictions	Simulations[1)] Wage rates increased by 10 per cent I. Male rates	II. Female rates	III. Both rates	IV Reductions in all marg. taxes by 5 per centage point	V One child less	VI Removal of hours restriction	VII Removal of hours restr. and a 5 per centage point cut in all tax rates.	VII Separate taxation replaced by joint	IX Separate taxation replaced by joint taxation and constant tax revenue[2)]
Male hours	2021.26	2021.16	-0.24	-0.24	-0.33	0.12	-0.08	- 4.10	0.55	-1.26	0.17
Female hours	1542.69	1542.40	-0.45	0.35	-0.32	0.23	1.95	-10.57	0.31	-6.89	-3.36
Total hours	3563.95	3563.56	-0.33	0.01	-0.33	0.17	0.80	- 7.04	0.45	-3.70	-1.38
Full-time males	0.69	0.70	0.70	0.70	0.70	0.70	0.70	0.09	0.09	0.68	0.69
Full-time females	0.30	0.28	0.27	0.28	0.27	0.28	0.30	0.03	0.03	0.22	0.25
Part-time 30h/w fem.	0.11	0.15	0.15	0.15	0.15	0.15	0.15	0.08	0.08	0.14	0.14
Part-time 20h/w fem.	0.16	0.18	0.18	0.18	0.18	0.18	0.17	0.08	0.08	0.20	0.19
Gross male earnings	109512	110515	0.76	-0.24	9.62	0.02	-0.10	- 4.43	0.22	-0.05	0.40
Gross female earnings	63088	65279	-0.45	10.09	9.29	0.02	1.79	-10.02	0.25	-3.05	-2.94
Gross total earnings	172600	175794	5.97	3.62	9.50	0.02	0.60	- 6.51	0.24	-1.15	-0.83
Net tax revenue	60465	63564	11.55	5.56	16.94	-11.45	0.78	- 8.59	-11.24	30.01	-
Household consumption	116849	116945	2.69	2.42	5.07	6.25	0.48	- 5.11	6.23	-17.26	-1.33

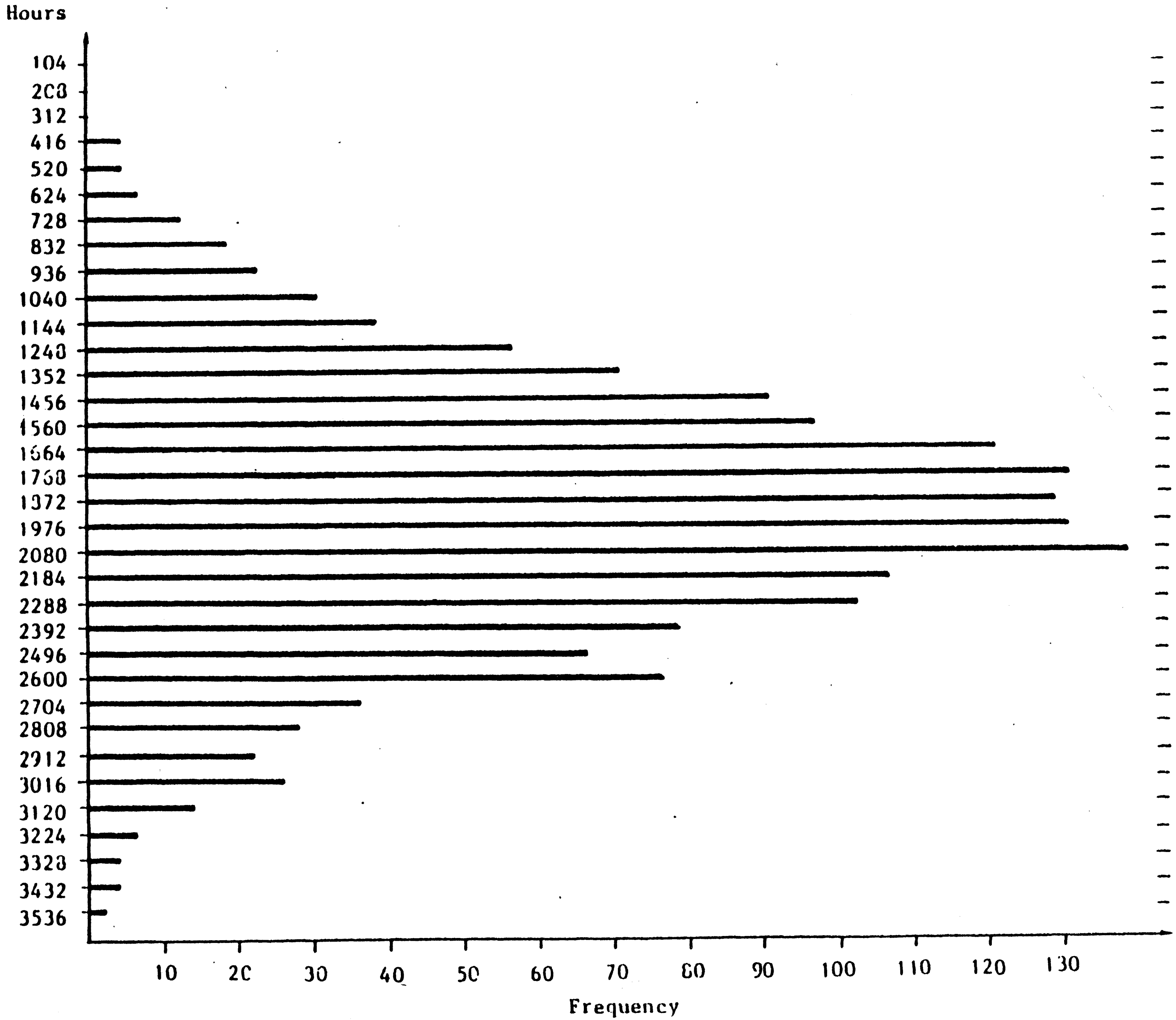
1) Base predictions give the average value of the variables. In the other simulations we give the changes in per cent of the base predictions, except for full-time/part-time fractions. In simulation VII, reduction in marginal tax rates, we express the changes in per cent of the outcome of simulation VI, removal of hours restrictions. "Hours" are hours a year and all economic variables are SEK a year.

2) In order to keep tax revenue constant tax rates have to be reduced. An across-the-board-cut on all tax rates is imposed and the model is used to calculate the needed reduction. It amounts to 22 per cent (not percentage points).

Table 6. Changes in gross earnings, taxes and household consumption, per capita values, decomposed into behavioral changes and changes due to variation in policy instruments.

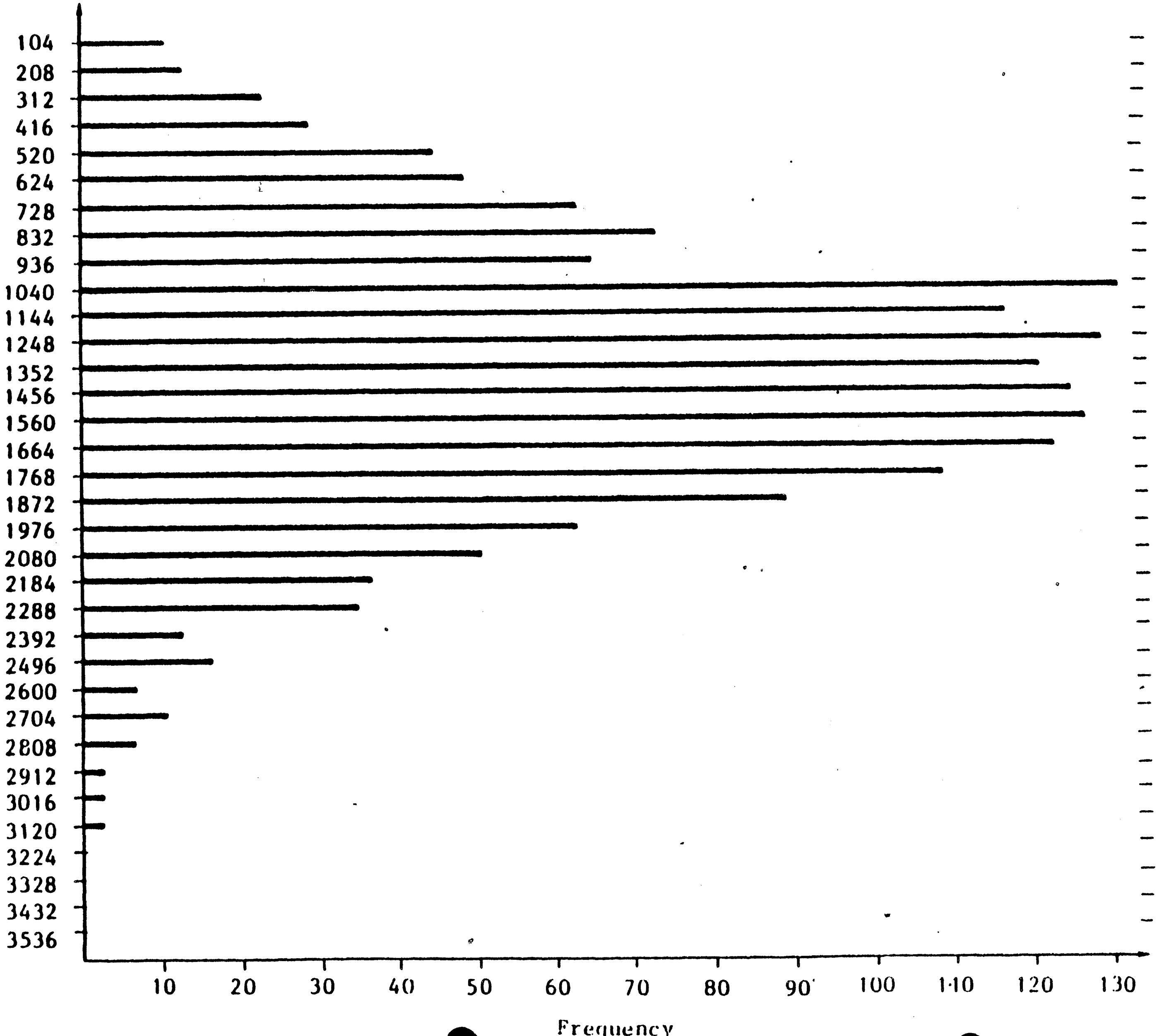
Variables	Overall wage increase of 10 per cent			Marginal tax cut of 5 percentage points.		
	Total change SEK	Percentage shares related to Wage-changes	Be-havioral	Total Change SEK	Percentage shares related to Tax change	Be-havioral.
Gross household earnings	16699	105.1	-5.1	31	0	100
Taxes	7128	107.4	-7.4	-10918	99.3	0.7
Household consumption	5931	105.2	-5.2	7308	98.6	1.4

Figure 9. Predicted frequencies of hours worked
by male after the removal of hours restriction.



Hours	Freq	Cum. freq	Percent	Cum. percent
104	0	0	0.00	0.00
208	0	0	0.00	0.00
312	0	0	0.00	0.00
416	4	4	0.24	0.24
520	4	8	0.24	0.49
624	6	14	0.36	0.85
728	12	26	0.73	1.58
832	18	44	1.09	2.67
936	21	65	1.27	3.94
1040	30	95	1.82	5.76
1144	37	132	2.24	8.00
1248	55	187	3.34	11.34
1352	69	256	4.18	15.52
1456	90	346	5.46	20.98
1560	96	442	5.82	26.80
1664	119	561	7.22	34.02
1768	129	690	7.82	41.84
1872	127	817	7.70	49.55
1976	130	947	7.88	57.43
2080	138	1085	8.37	65.80
2184	105	1190	6.37	72.16
2288	101	1291	6.12	78.29
2392	77	1368	4.67	82.96
2496	65	1433	3.94	86.90
2600	76	1509	4.61	91.51
2704	36	1545	2.18	93.69
2808	28	1573	1.70	95.39
2912	22	1595	1.33	96.73
3016	25	1620	1.52	98.24
3120	14	1634	0.85	99.09
3224	6	1640	0.36	99.45
3328	3	1643	0.18	99.64
3432	4	1647	0.24	99.88
3536	2	1649	0.12	100.00

Figure 10. Predicted frequencies of hours worked by females after the removal of hours restriction.



	Freq	Cum. freq	Percent	Cum. percent
104	10	10	0.61	0.61
208	12	22	0.73	1.33
312	21	43	1.27	2.61
416	28	71	1.70	4.31
520	43	114	2.61	6.91
624	47	161	2.85	9.76
728	61	222	3.70	13.46
832	72	294	4.37	17.83
936	64	358	3.88	21.71
1040	130	488	7.88	29.59
1144	116	604	7.03	36.63
1248	128	732	7.76	44.39
1352	119	851	7.22	51.61
1456	123	974	7.46	59.07
1560	125	1099	7.58	66.65
1664	121	1220	7.34	73.98
1768	107	1327	6.49	80.47
1872	87	1414	5.28	85.75
1976	62	1476	3.76	89.51
2080	50	1526	3.03	92.54
2184	36	1562	2.18	94.72
2288	34	1596	2.06	96.79
2392	11	1607	0.67	97.45
2496	16	1623	0.97	98.42
2600	6	1629	0.36	98.79
2704	10	1639	0.61	99.39
2808	5	1644	0.30	99.70
2912	2	1646	0.12	99.82
3016	2	1648	0.12	99.94
3120	1	1649	0.06	100.00
3224	0	1649	0.00	100.00
3328	0	1649	0.00	100.00
3432	0	1649	0.00	100.00
3536	0	1649	0.00	100.00

APPENDIX 1: Data

Data used in this study is a subsample from the Swedish Income Distribution Survey 1981 (HINK81), collected by the Central Bureau of Statistics Sweden. These annual, representative cross section surveys contain primary data from two rolling panels. Besides filled-in tax returns checked and approved by the tax authorities, together with record data from the municipalities and the social security authorithies, there are survey data based on interviews with both spouses. HINK81 contains about 9600 households and 24500 individuals, including children.

A HINK-household either consists of two adults and their children (if any), or one adult with or without children. A 18 years old (or older) person 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 people 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.

The women's age is between 26 and 65, while men are included if they are not older than 65. Individuals with hourly wage-rates below SEK 10 and above SEK 170, and hours of work above 3600 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 working weeks during the year. The hourly wage rate is calculated as income from work divided by hours worked a year. Dividing local income taxes payed by local taxable income give "the local tax rate".

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

- received maintenance for children,
- childrens allowances
- housing allowances
- welfare payments

- allowances for children between 16 and 18 years old 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 the households income.

Dummy variables for region (A18), socioeconomic group (A13) and for living in a house of their own (A19) are constructed as follows:

If the household is located in Stocholm, Gothenburg or Malmö, or in other "large cities", A18=1. Otherwise A18=0. People normally organized in LO (Labor Unions Organization) and "not classified people" are classified as blue collar workers, that is A13 = 0. Otherwise A13=1. If either the man or the woman, or both of them own the house in which they live, A19=1. Otherwise it is zero.

APPENDIX 2: Swedish tax rules as of 1981.

In 1981 B-incomes were still taxed jointly in Sweden. B-incomes are mostly capital income. A-incomes or labor earnings are separately taxed. A-income also include sick and parental benefits, and pension payments. The tax rules for A-incomes can be described as follows. Let A_j denote the earnings of spouse j;

$$A = \sum_{i=1}^{2} A_j$$

(1) $$\text{where } A_j = a_j A \quad , \qquad j = M,F \; ,$$

$$\sum_{i=1}^{2} a_j = 1 \; .$$

A is the family income and a_j is the share of spouse j

(2) $$b_{1j} > 100 \qquad\qquad j = 1,2$$

where b_{1j} is deductions for expenses associated with work. If no expenses are specified, one is allowed to deduct 100 SEK. Eqs. (1) and (2) give the net income from labor. Total income is the sum of net income from other sources and net income from labor. From total income several general deductions are also permitted (including deficits), of which we specify:

(3) $$b_{2j} = mq \quad , \quad j = M,F \; ,$$

m = number of children for whom expenses are paid when the parents are separated.

q = the highest amount that could be deducted for each child, that is SEK 3000.- as of 1981.

(4) $$b_{3j} = 0.25(A_j - b_{1j}) \lessdot 2000 \; .$$

b_3 is deducted only if there is at least one child under the age of 16 in the family, and the income earners have lived in Sweden more than half the year.

To simplify matters, we add all the deductions:

$$(5) \qquad B_j = \sum_{i=1}^{3} b_{kj} \,, \qquad j = M,F \,.$$

The amounts subject to assessment for national income taxes, denoted E_j^g is then calculated as follows:

$$(6) \qquad E_j^g = A_j - B_j = F_j^S \,, \qquad j = M,F \,.$$

For 1981 this assessed income, with some exceptions, is the same as federal taxable income ($\bar{F}_j^s$). From assessed income we then deduct at most 6000 SEK, that is for people who lived in Sweden the whole year:

$$(7) \qquad F_j^k = E_j^g + \frac{g^a}{2} - g_j^r \,, \qquad j = M,F,$$

where F_j^k is local taxable income,

g_j^r is the basic deduction of 6000 SEK

and g^a is the guarantee amount for real property in the municipality,

National income taxes follow from (6) and the federal tax schedule for 1981. Local income taxes are given by:

$$(8) \qquad G_j^k = T^k F_j^k \qquad j = M,F \qquad k = 1,\dots,m$$

where T^k is the local taxe rate and G_j^k are the local income taxes in region k.

The sum of income taxes is given by:

$$(9) \qquad H_j = G_j^S + G_j^k \qquad j = M,F, \qquad k = 1,\dots,m$$

where G_j^S is the national income tax.

There is an upper bound on marginal taxes. Let

$$(10) \qquad I = \sum_{j=M,F} H_j \, .$$

Related to H_j and I there are the following two rules:

$$(11) \qquad \begin{aligned} & H_j < 0.80(F_j^S - 4500), \text{ if } (F_j^S - 5400) < 192000 \\ & H_j < 0.80(F_j^S - 4500)+0.85(F_j^S - 4500-192000), \\ & \text{if } F_j^S > 192000 \quad , \qquad j = M,F \ , \end{aligned}$$

for people taxed separately and

$$(12) \qquad \begin{aligned} & I < 0.80 \sum_{j=M,F} (F_j^S - 4500), \text{ if } \sum_{i=M,F} (F_j^S - 4500) < 192000 \\ & I < 0.80 \sum_{j=M,F} (F_j^S - 4500)+0.85 \sum_{j=M,F} (F_j^S - 4500-192000), \\ & \text{if } \sum_{j=M,F} (F_j^S - 4500) > 192000 \end{aligned}$$

for people taxed jointly.

<u>Ordinary tax reductions</u> are calculated as:

$$(13) \qquad \begin{aligned} & J_j^o = \alpha\beta(\gamma - E_j^g), \qquad \text{if } E_j^g < \gamma \\ & J_i^o = 0, \qquad \text{if } E_j^g > \gamma \qquad i,j = F,M, \ i \neq j \end{aligned}$$

where α=1 for a person who has lived in Sweden and where the spouse also has lived in Sweden more than half of 1981, and α=0.5 for a person who has lived in Sweden and where the spouse has lived less than half of 1981,

and β=0.3, γ=6000 for people taxed jointly. Furthermore,

(14) $J_j^o = \alpha \cdot 1800$ for single persons with children under the age of 18, living at home.

Special tax reductions are calculated as:

$$J_j^S = 560, \text{ if } F_j^S < 40000,$$

$$J_j^S = 560+0.10(F^S - 40000), \text{ if } 40000 < F^S < 45000,$$

(15) $$J_j^S = 1060, \text{ if } 45000 < F_j^S < 60000,$$

$$J_j^S = 1060-0.03(F_j^S - 60000), \text{ if } 60000 < F_j^S < 76600,$$

$$J_j^S = 560, \text{ if } F_j^S > 77600 , \qquad j = F,M.$$

Total income tax for the household is then given by:

(16) $$K = I^e - \sum_{j=M,F} (J_j^o + J_j^S)$$

where I^e is the sum of national and local income taxes after the limitation rule have been used, but before tax reductions.

The net amount of income taxes, transfer payments and benefits denoted R, is calculated as follows:

(17) $$R = K + O - P + N - nQ + mQ + T_t^f ,$$

where O is housing allowances,
P is children allowances,
N is recommended fees for childrens daycare,
Q is maintenance for children,
n is the number of children for whom maintenance for children is received,
m is the number of children for whom maintenance of children is paid,
T^f is the real property tax on houses.

The basis for housing allowances and fees for childrens day care are both depending on the family income.

(16) and (17) now give us the average income taxes (X), marginal taxes (Y) and total marginal effects (Z) in tax brackets v, as follows:

$$X_v = \frac{R_v}{A_v}, \qquad v = 1,\ldots,400, \tag{18}$$

$$Y_{v+5} = \frac{K_{v+5} - K_v}{5000}, \qquad n = 1,\ldots,395, \tag{19}$$

$$Z = \frac{R_{v+5} - R_v}{5000}, \qquad v = 1,\ldots,395, \tag{20}$$

where $v = 1$ for $A = 1000$ SEK and

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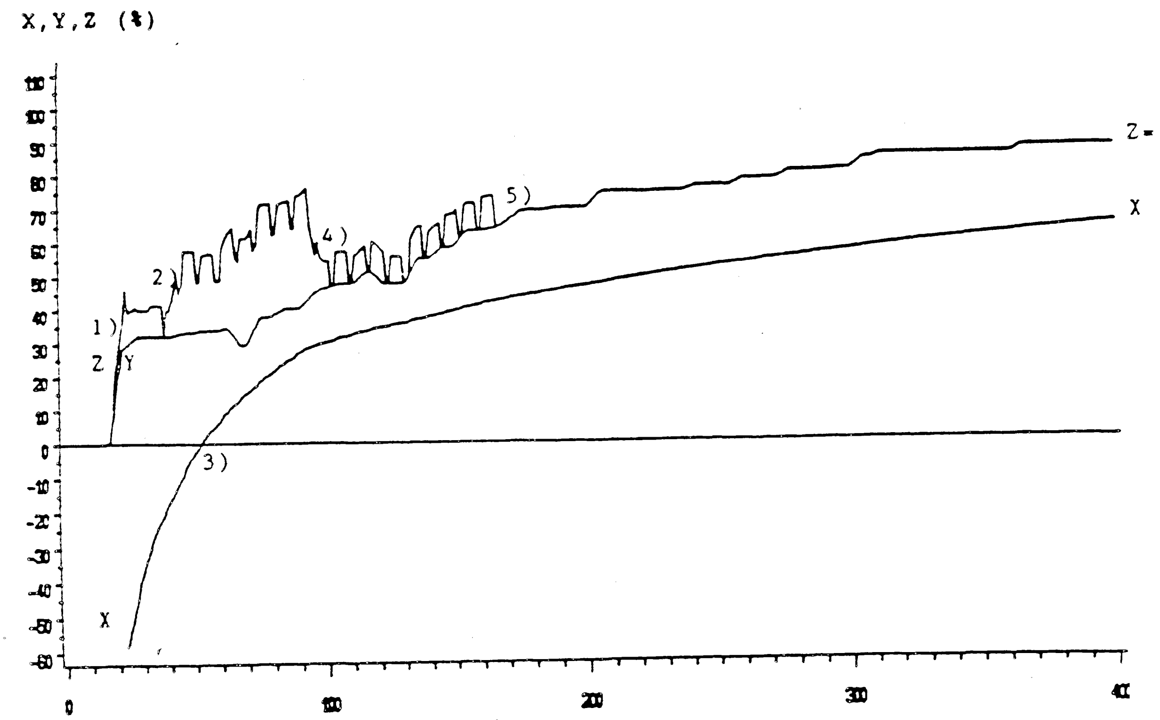
$v = 395$ for $A = 395000$ SEK.

For jointly taxed people the national B-incomes are taxed on top of the highest federal taxable A- income in the household. The amount is then divided referring to how large the B-incomes are for each spouse.

In Figures 11-14 we show how X,Y and Z vary with income in four different types of household. The figures clearly demonstrate that the total tax and transfer system in Sweden is not uniformly progressive. Total marginal effects from income taxes, day nursery fees and housing allowances vary with income in an volatile way.

Figure 11.
Tax-schedules for wage earners 1981. Married couples/cohabitants with 2 children and 2 incomes from employment. Both children in kindergarten. Local tax rate: 30%. Income steps: 1000 SEK.



FAMILY GROSS INCOME FROM EMPLOYMENT (in thousands SEK)
(64% + 36% from each spouse)

Y = Marginal Income Taxes after income changes by SEK 5 000

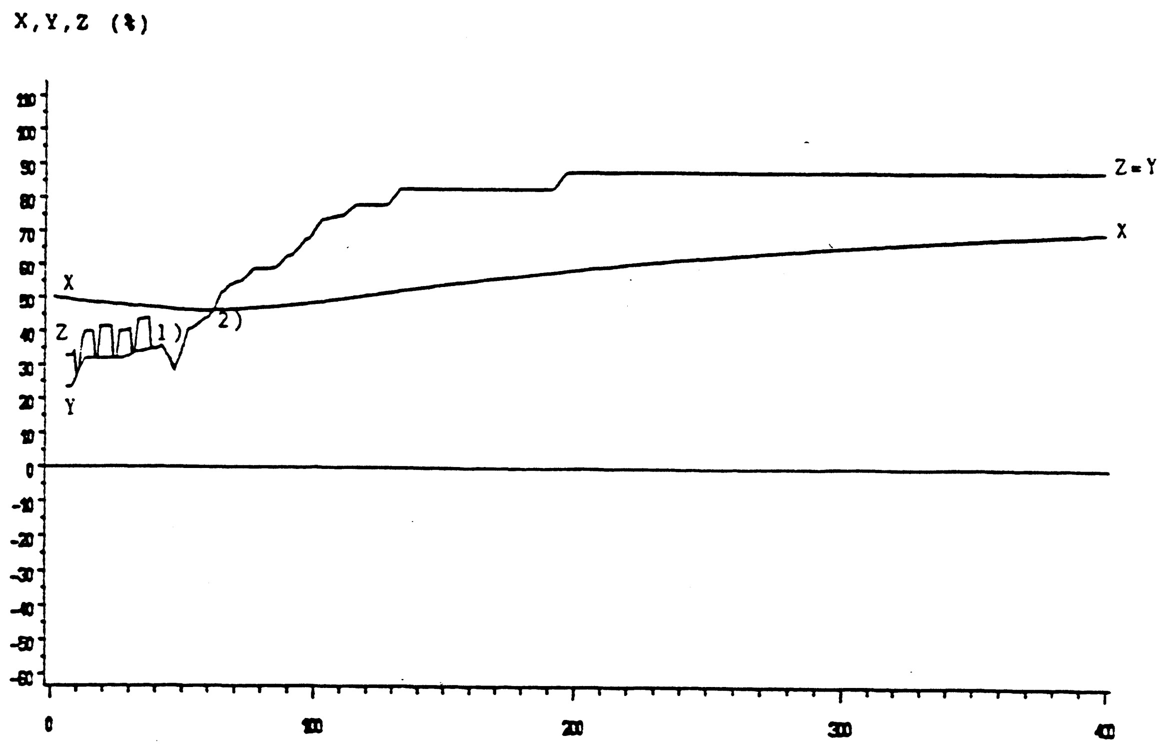
Z = Total Marginal Effects from Income Taxes, Kindergarten Fees and Housing Allowances after income changes by SEK 5 000

X = Net average Taxes/Subsidies from Income Taxes, Kindergarten Fees, Housing Allowances and Child Allowances after income changes by SEK 5 000

1) The fees for childrens day care begin to increase with the family income.
2) The housing allowances begin to decline with the family income.
3) The break even point for paying (net) income taxes.
4) The housing allowances decline to zero.
5) The fees for childrens day care stop increasing.

Figure 12.

Tax-schedules for wage earners 1981. Married woman/cohabitant with 2 children and 2 incomes from employment. Both children in kindergarten. Local tax rate: 30%. Income steps: 1000 SEK.



INDIVIDUAL GROSS INCOME FROM EMPLOYMENT (in thousands SEK)
(The other spouse earns SEK 128 000 a year, which corresponds to full-time work for men in 1981.)

Y = Marginal Income Taxes after income changes by SEK 5 000

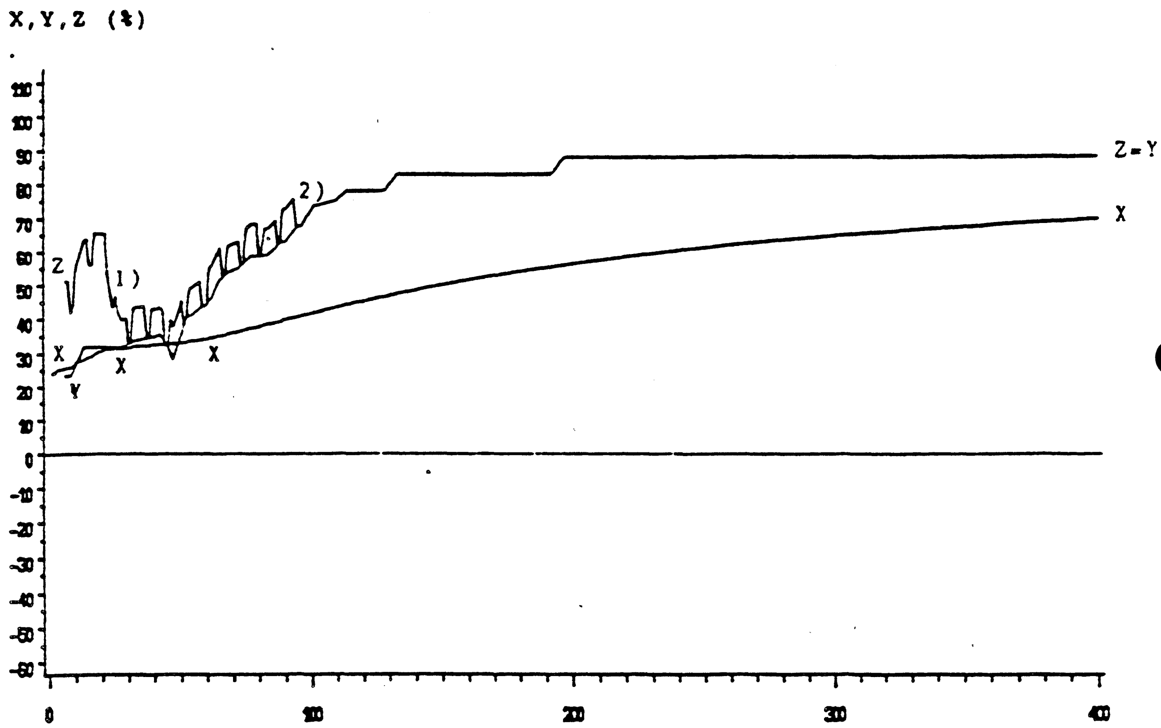
Z = Total Marginal Effects from Income Taxes, Kindergarten Fees and Housing Allowances after income changes by SEK 5 000

X = Net average Taxes/Subsidies from Income Taxes, Kindergarten Fees, Housing Allowances and Child Allowances after income changes by SEK 5 000

1) The fees for childrens day care stop increasing.

2) Net average taxes/subsidies at its lowest level.

Figure 13.
Tax-schedules for wage earners 1981. Married man/cohabitant with 2 children. 2 incomes from employment. Both children in kindergarten. Local tax rate: 30%. Income steps: 1000 SEK.



INDIVIDUAL GROSS INCOME FROM EMPLOYMENT (in thousands SEK)
(The other spouse earns SEK 72 000 a year, which corresponds to full-time work for women in average the income year 1981.)

Y = Marginal Income Taxes after income changes by SEK 5 000

Z = Total Marginal Effects from Income Taxes, Kindergarten Fees and Housing Allowances after income changes by SEK 5 000

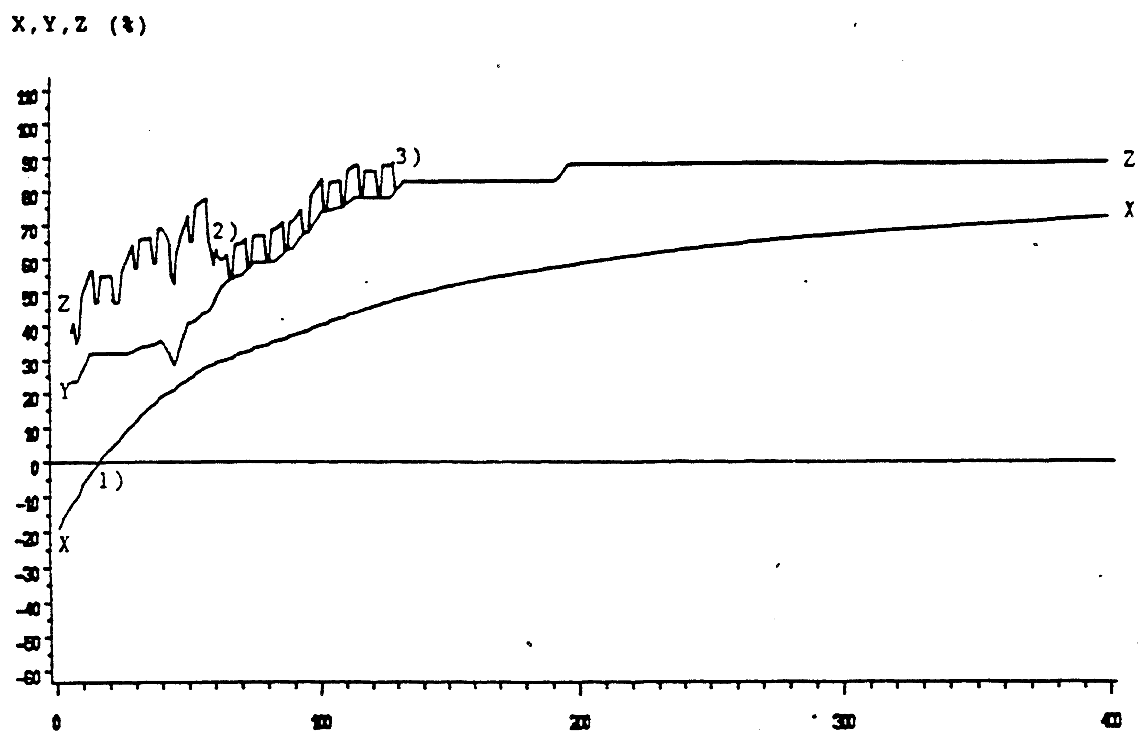
X = Net average Taxes/Subsidies from Income Taxes, Kindergarten Fees, Housing Allowances and Child Allowances after income changes by SEK 5 000

1) The housing allowances decline to zero.

2) The fees for childrens day care stop increasing.

Figure 14.

Tax-schedules for wage earners 1981. Married man/cohabitant with 2 children. 2 incomes from employment. Both children in kindergarten. Local tax rate: 30%. Income steps: 1000 SEK.



INDIVIDUAL GROSS INCOME FROM EMPLOYMENT (in thousands SEK)

(The other spouse earns SEK 36 000 a year, which corresponds to a half-time work for women in average the income year 1981.)

Y = Marginal Income Taxes after income changes by SEK 5 000

Z = Total Marginal Effects from Income Taxes, Kindergarten Fees and Housing Allowances after income changes by SEK 5 000

X = Net average Taxes/Subsidies from Income Taxes, Kindergarten Fees, Housing Allowances and Child Allowances after income changes by SEK 5 000

1) The break even point for paying (net) income taxes.

2) The housing allowances decline to zero.

3) The fees for childrens day care stop increasing.

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