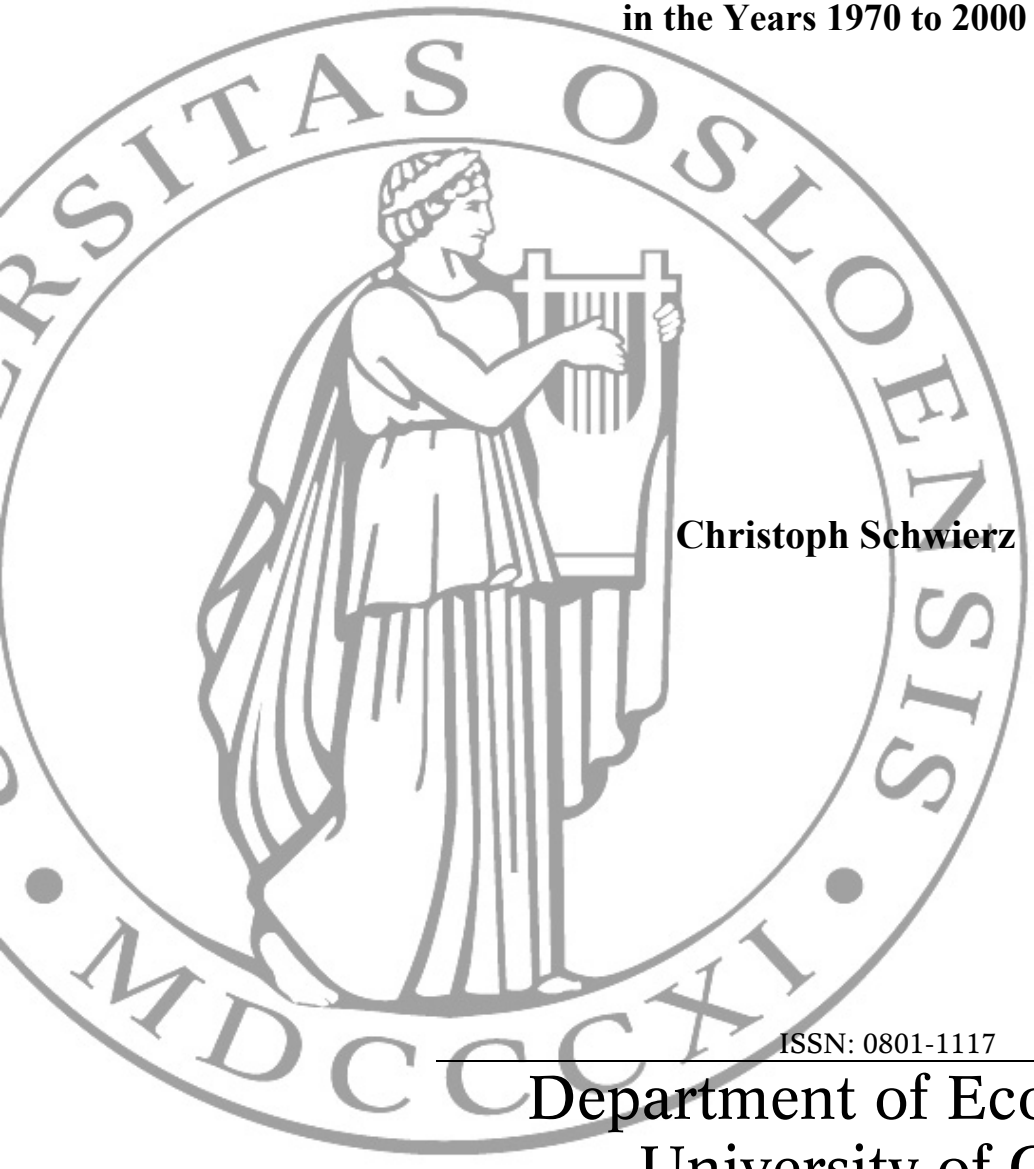
MEMORANDUM

No 33/2003

The Effects of Taxes and Socioeconomic Variables on Market Work and Home Production in Norway in the Years 1970 to 2000



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ISSN: 0801-1117

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This series is published by the
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The Effects of Taxes and Socioeconomic Variables on Market Work and Home Production in Norway in the Years 1970 to 2000

Christoph Schwierz[1]

March 2003

Abstract

This paper analyses significant forces of the allocation of time to different home production activities, as developed by Gronau, in a data set consisting of decennial time-use surveys of Norwegian households. The theoretical framework consists of joint allocation of time model, where household decisions to allocate time between the market and the household are analyzed simultaneously. The estimation takes place within a limited dependent variables framework. As an alternative to the usually employed Tobit model, Cragg´s double-hurdle model is used, so as to be able to model individual decisions in a two step framework, discerning between the wish to participate and the amount of time to invest in different activities. The conclusion of the paper is that taxation has a significant effect on the allocation of time to market and non-market activities. There is evidence in favour of more disaggregation of time-use, but the overall message of the home production literature – that explicit consideration of the market-versus-home production margin can improve estimates of labor supply elasticities - is upheld.

Keywords: home production, allocation of time, double-hurdle model, labor supply elasticities

This paper is part of the project "Own production, taxation and tax evasion - a theoretical and empirical study" in the Frisch Centre (Research Council project number 143640/510). The project leader is Jon Strand from the Department of Economics in Oslo University. *Acknowledgements.* I am grateful to Jon Strand and Steinar Strøm for helpful suggestions on the paper and Odd Vaage from Statistics Norway for providing the data set used in this paper. I also want to thank my colleagues from the Frisch Centre for the productive and friendly atmosphere during my work at the institute.

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1 Introduction

1.1 Home economics and the motivation of the study

"The theory of home production plays a role in the realization that economic considerations are as important in the home sector as in the market"[1]. This remark by Reuben Gronau points out that for a long time households and their production activities have been neglected by economists, although economic considerations can play an equally important role in the households as in the market. As countries industrialize, a large part of household production of food, clothing, furniture and housing is transferred to business organizations and then purchased by households. Nevertheless, even in a world apparently dominated by the market, a large amount of household production is necessary. While the market economy produces many goods and services not produced by households, in many cases the market and the household are in direct competition, producing identical or similar goods and services.
With few exceptions, economic textbooks focus on households as consumers and fail to discuss households as producers using their own labor and capital. Households are presented to the modern student of economics as places of consumption. Economics theory focuses on consumer behaviour, which concerns the choice of households on the quantities of the commodities they choose to purchase, given the limitations of their money incomes and the prices of commodities.

The purpose of this study will be to analyse the significant forces of the allocation of time to different household production activities. This will be done in a joint allocation of time framework, where household decisions to allocate time between the market and the household will be analyzed simultaneously. While the major interest of this study will be to discern the effects of marginal taxes on labor income on the allocation of time between market, household work and leisure, it will also provide some insight on the effects of socioeconomic variables influencing the allocation of time. Since the Norwegian tax system has undergone severe changes in the last 30 years, the author hopes to find significant effects of marginal tax rate changes on labor income to changes in time use of households. This study analyses a large data set from four Norwegian time-use surveys distributed over a period of 30 years. It therefore potentially not only allows to discern the effects of socioeconomic factors in a

[1] Gronau (1997), p. 201

certain point of time but also their changing influence on the allocation of time through time. To the author´s knowledge this is the first analysis of a variety of household activities on the basis of Norwegian time-use data. As has been shown by Kapteyn and Kooreman (1987), such a disaggregated analysis of household work may be better able to locate the effects of socioeconomic factors than a purely aggregated analysis of household production, since little movement in aggregated household work may mask considerable shifts in its components.

The framework of analysis will be a model of time allocation. Models of time allocation ascribe economic significance to home production and try to model explicitly which socioeconomic factors affect the productive activities of the household. They date back to the 1970s and have given rise to a diverse literature, among which household production has formed an important topic. In the first models the household is seen as a production unit which combines intermediate goods with the time of household members to produce basic commodities[2]. The framework of the models is general, static, and emphasizes responses of individuals to market prices, time prices, incomes, and technologies influencing the production function of home goods. Household members are faced with a choice between paid market work, unpaid domestic work and leisure. Although these early models accept a considerable simplification and restriction of possible mechanism influencing household production activities, they allow for easy predictions and testability of model hypotheses. However, since the emergence of the first models more elaborate time use models appeared emphasizing joint production or intertemporal time use. For a review of the literature see Juster and Stafford (1991) and for more recent developments since 1990 see Klevmarken (1999).

The basic idea of allocation of time models was introduced by Becker (1965). According to Becker, market goods and services can only generate utility if they are combined with the consumer's time. For example: Having a ticket for the cinema does not generate utility. The consumer needs time to go to the cinema, watch the film and return home. So human beings experience utility from the commodities produced in the household with a combination of intermediate market goods and household time. Normally there are several techniques available to produce a final commodity. Since there are intermediate time inputs, which in most cases can be substituted by market inputs, people with differing time values will choose different production strategies, i.e. people with a high wage rate may choose less time-

[2] See Becker (1965) and Gronau (1977) and (1986).

intensive, but financially more costly technologies more often than people with a lower wage rate. Although in real world it is very difficult to obtain information on intermediate market goods used in home production, this study will use time inputs information for further analysis.

In chapter 1.2 a few major features of the Norwegian tax system and the major changes of the marginal tax rates on labor income from the year 1970 to the year 2000 will be presented. In chapter 2.1 the theoretical framework of a household production model will be discussed. It will be an extended version of the basic Gronau model of home production, presented as a simultaneous equations model with one equation for market work and one for the different household activities. Beyond that a graphical representation will be given in order to better illustrate the functioning of the model. Chapter 2.2 will present the most important restrictions of the model and possible extensions of the model framework proposed by economic literature. In chapter 2.3 the empirical specification of the model will be given, where assumptions about the form of the marginal rate of substitution between consumption and leisure and the marginal productivity of home production will be made.

In chapter 3.1 some general remarks on the characteristics of time use data will be discussed. Since time use data often has the disadvantage of reporting too many zeros for a particular time use category, this disadvantage will have to be put up with during the estimation. After the presentation of major characteristics of the actual data set in chapter 3.2, the estimation procedure will be discussed in chapter 4. The first part of the chapter will deal with the estimation of wage variables, since they have not been provided in detailed form by the original data sets. This will be done by the use of the two-step Heckman estimation procedure. Also, specific assumption will have to be made to get estimates of nonlabor income. Beyond that the problem of endogeneity of the marginal tax rate will be discussed and estimates of tax rates will be presented.

Since many of the individuals have reported zero time-use on different activities, the estimation will have to take place within a limited dependent variables framework. Although this problem is usually dealt with a Tobit model, Cragg´s double-hurdle model will be estimated as an alternative to the Tobit model in chapter 4.2. The advantage of the double-hurdle model is that it allows distinguishing between “wrong” and “correct” zeros, while the Tobit model takes for granted that all reported zeros can be regarded as the outcome of individual choice. Due to the specific characteristic of time-use to data to report too many

zeros for the single market and household activities, this has already been shown to be important in previous studies.
In chapter 5 the estimation results will be discussed. Chapter 5.1 contains detailed results on own- and cross-wage-elasticities of the supply of labor to both market and home activities, as well as the corresponding nonlabor income elasticities. Chapter 5.2 will discuss the effects of the other socioeconomic variables used in the estimation. Finally chapter 6 will conclude the discussion of the study and make some proposals to improve future research on this topic.

1.2 A brief outline of the Norwegian tax system

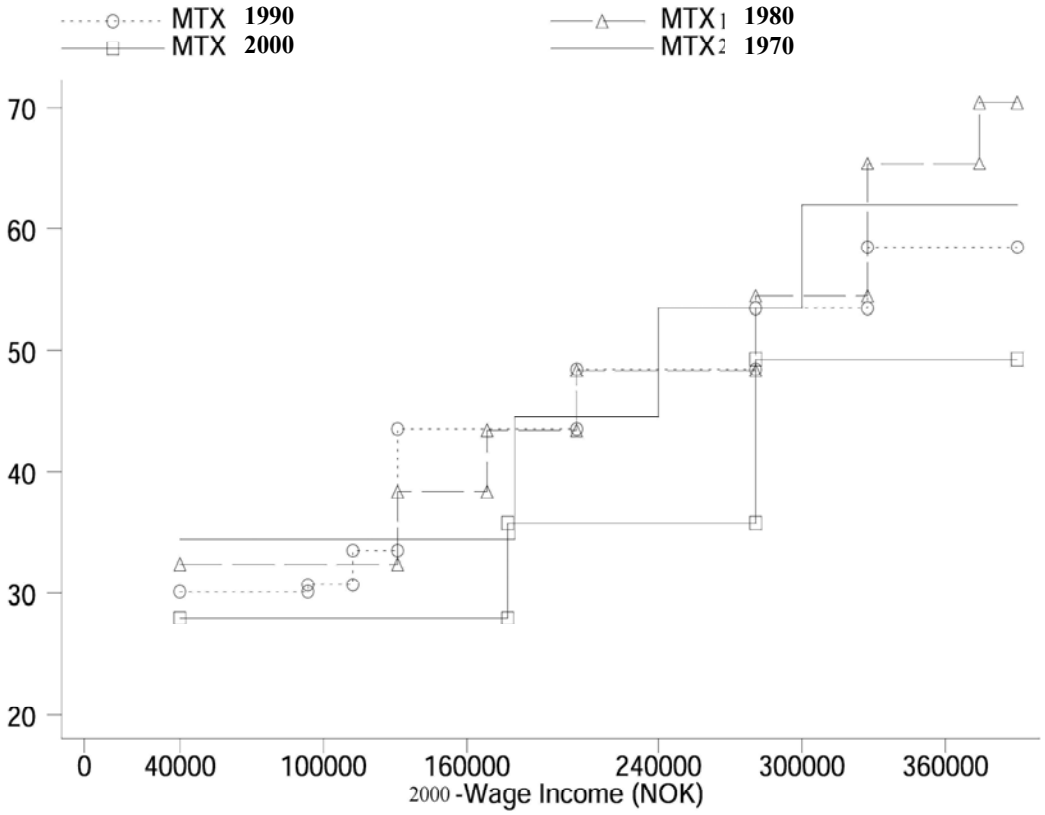
As stressed by Noor (2000) the Norwegian tax system is characterized by a stronger emphasis on income redistribution, a wider social safety net and a broader provision of social services than most other OECD countries. A key to the design of the Norwegian tax system is also the overriding objective to keep remote areas populated, notwithstanding an overall very low population density. Beyond that the Norwegian economy is characterised by the availability of huge natural resources (oil, gas, hydropower, forestry and fisheries), that have served to fund the expansion of the welfare state and have influenced the tax system.

These features of the Norwegian economy have been conducive to calls for preferential tax treatment of specific sectors or regions, resulting in a tax system that by the late 1980s was blurred by a plethora of special exemptions and allowances. Spurred by developments in other OECD countries, Norway implemented a broad tax reform in 1992. Both the personal income taxation and the corporate taxation were reformed. The main purpose was to reduce tax-induced distortions to a minimum by lowering the tax rates and broadening the tax base. Thus incentives to work and save should be increased and incentives of tax avoidance and activities in the ”black” market should be decreased. The reform also involved a significant step towards a more neutral tax system with respect to the type of economic activity and the organisational and financial structure of such activity.

The centrepiece of the reform was the move towards a pure dual income tax in 1992, which strictly separates the taxation of labour and capital income at the level of individual taxpayers. The dual income tax system taxes all forms of capital income at a rate of 28 per cent while labour income is taxed at a higher progressive rate.

Figure 1 shows the development of marginal tax rates (in %) of married couples by tax assessed income in constant Norwegian crowns for the years 1970, 1980, 1990 and 2000[3]. For the years depicted in the figure the major developments up to 2000 can be summarized in two points. First, there is a decrease of the number of different marginal tax rates for a given year since 1980. While seven different marginal tax rates existed in the year 1980, only 3 marginal tax rates remained in 2000. The second modification of the tax system had the effect of gradual decreases in the marginal tax rates. With 70.2 per cent the marginal tax rates on wage income were at its peak at the end of the 1980s. This top marginal rate has been reduced to 49.3 per cent for a salaried employee in 1999[4].

FIGURE 1 MARGINAL TAX RATES ON WAGE INCOME IN 1970, 1980, 1990 AND 2000



This variation in the tax rates for given income levels is so large that one might expect observable adjustment effects in labor supply as a result of these changes. In a cross section

[3] The marginal tax rates have been obtained from the following publications of Statistics Norway: Aktuelle Skattetall (1984), p. 21; Aktuelle Skattetall (1991), p.21 and Noor (2000),pp. 35-7.

[4] In 2000 a new bracket in the surtax, applied to personal (labour and pension) income of NOK 762 700 and above, has been introduced. The rate is 19.5 per cent, which raises the top marginal rate for personal income by six percentage points. However, as emphasized by Aaberge et al. (1995, p.636) there could be a considerable difference between the effective and formal marginal tax rates. In 1979 all interest payments were deductible against a maximal marginal tax rate , while later deductions were only allowed against a marginal tax rate of 28 percent. These changes in deduction rules implie that differences between the effective rates are much smaller as compared to the differences in formal tax rates.

study for married Swedish males for the years 1984, 1986 and 1988 Flood (1998) finds indications that both the degree of progressivity and the tax level produce different labor supply elasticities. This stems from the fact that a higher number of kinks, i.e. more differentiation in marginal tax rates, produces a higher probability to find individuals close to a kink implying stronger incentive effects. Another interesting result from this study is, that not only the number of kinks but also their location is important. A long initial segment as the one in the above Figure for the year 1990 followed by a large degree of progressivity implies very different estimated supply elasticities compared to the year 1970, which has, on average, lower levels but a higher progressivity especially for smaller incomes.

Another characteristic of the Norwegian tax law is, that married couples are required to file their income returns jointly. Separate filing was introduced as an option in 1957, and in 1970 the system of differentiated tax schedules, according to the number of dependents, was replaced by a simplified version with two tax schedules: one for single persons and for spouses filing separately, and a more favorable one for married couples filling jointly, as well as for single parents. Of course, the problem of joint taxation has the negative effect of high marginal taxes on the second income. A Norwegian study by Aaberge et al. (2000) finds an increase in the labor supply of married women with equalized tax schedules across marital status.

The few major facts about the Norwegian tax system show that very detailed information about working hours, wage rates and incomes may be necessary in order to model labor supply behaviour in a more accurate way. These information are necessary in order to get a good representation of the individual budget sets, which may approximate the complex implications of different tax legislation and transfer systems of most Western countries. However, data sets which provide detailed information on tax and income variables are seldom, and the data sets used in this study give rather rough information on these variables. This problem will be dealt with in chapter 4.1.

2 The theoretical model

2.1 The Gronau model

The model introduced by Gronau (1980) which shall be my analytical framework and shall serve for further estimation purposes, makes a distinction between work, leisure and

household production time. In his framework household utility depends on two commodities: consumption goods (X) and leisure time (L)

$U = U(X,L)$

, where it is assumed that individual welfare (U) is strictly increasing, quasi-concave and twice differentiable.

The household can obtain consumption goods in two ways. First, it can produce them at home (Z). The second way to obtain consumption goods is to become a wage-earner and use the earnings to purchase consumption goods (X_M) on the market. Total goods consumption stems from goods purchased at the market or goods produced at home.

$X = X_M + Z$ for i = 1,…n. (1)

Home goods are produced using market inputs (X_H) and time inputs (i.e., time spent at a particular home production activity H),

$Z = f(X_H, H)$ (2)

subject to decreasing marginal productivity $f_{X_H} > 0, f_H > 0, f_{X_H X_H} < 0, \text{and } f_{HH} < 0$.

The maximization problem is subject to three constraints:

1. The budget constraint specifying that in this one-period model market consumption cannot exceed money income.

$X_M \leq WN + V - t(I)$ (3)

where W is gross wage per hour, N is hours of market work, V is non-labour income and t is the total amount of income taxes paid, which is a function of taxable income I. Taxable income is defined as WN+V-D, where D is total deductions. This extension of the budget constraint used in Gronau (1980) is specified in Flood (1987b), who analyzes the effects of taxes on market and non-market labour supply in Sweden. In the following I will largely use his extended modelling structure. However, in contrast to his study I will also present the estimation results for disaggregated home production activities as well as a different estimation technique.

The second constraint is the time constraint

$L + H + N = T$ (4)

Specifying that time (T) is a scarce resourse to be allocated among its three uses – leisure, work at home and work in the market. The last constraint is a non-negativity constraint

$H, N \geq 0$. (5)

The tax-function in (3) is approximated by

$$t = t_j + t_m(I - I_j) \tag{6}$$

where I_j is the smallest taxable income in the observed tax-bracket j, t_j is the tax payable at that income and t_m is the marginal tax-rate.

Now (3) can be substituted into (6), which results in

$$X_M \le W_m N + V(1 - t_m) - t_j + t_m I_j \tag{7}$$

where $W_m = W(1 - t_m)$ is the marginal wage rate. Thus the individual chooses inputs of time to maximize utility subject to the technological (2), time (4), non-negativity (5) and budget constraints (7), specifically

$$\begin{aligned} \Lambda &= U(X_M, Z, L) + \\ &\quad \lambda(W_m N + V(1 - t_m) - t_j + t_m I_j - X_m) + \mu(T - L - H - N) \\ &= U(X_m, f(H), L) + \\ &\quad \lambda(W_m N + V(1 - t_m) - t_j + t_m I_j - X_m) + \mu(T - L - H - N) \end{aligned} \tag{8}$$

which yields the following first order conditions:

$$\left.\begin{aligned} \frac{\partial \Lambda}{\partial X_m} &= \frac{\partial U}{\partial X_m} - \lambda = 0 \\ \frac{\partial \Lambda}{\partial L} &= \frac{\partial \Delta}{\partial L} - \mu = 0 \end{aligned}\right\} \Rightarrow \frac{\frac{\partial \Lambda}{\partial L}}{\frac{\partial \Lambda}{\partial X_m}} \equiv S = \frac{\mu}{\lambda} \tag{9}$$

$$\left.\begin{aligned} \frac{\partial \Lambda}{\partial H} &= \frac{\partial \Lambda}{\partial Z}\frac{\partial Z}{\partial H} - \mu \le 0 \Rightarrow f' - \frac{\mu}{\lambda} \le 0 \Rightarrow S - f' \ge 0 \\ H\frac{\partial U}{\partial H} &= 0 \qquad \Rightarrow \qquad H(S - f') = 0 \end{aligned}\right\} \tag{10}$$

$$\left.\begin{aligned} \frac{\partial U}{\partial N} &= \lambda W_m - \mu \le 0 \Rightarrow W_m - \frac{\mu}{\lambda} \le 0 \Rightarrow S - W_m \ge 0 \\ N\frac{\partial U}{\partial N} &= 0 \qquad \Rightarrow \qquad N(S - f') = 0 \end{aligned}\right\} \tag{11}$$

Thus the first order conditions are given as,

$$H(S - f') = 0 \qquad (12)$$

$$N(S - W_m) = 0 \qquad (13)$$

where S is the marginal rate of substitution between consumption and leisure, also called the shadow wage of leisure and f ´ is the marginal productivity in home production.

Condition (12) says, that for an interior solution with respect to H (H>0) the shadow wage of leisure must equal the shadow wage of home production, while no time will be spent on home production if f ´<S. However, from (10) follows that $S \geq f'$, the shadow wage of leisure must be at least as large as the shadow wage of home production.

Condition (13) says that for an interior solution with respect to N (N>0), the shadow wage of leisure must equal the marginal wage rate, while if $W_m < S$ hours of market work will be zero. Also from (11) we know $S \geq W_m$, that is, the shadow wage of leisure must be at least as large as the marginal wage rate.

In order to illustrate further the functioning of the model in cases of a change of nonlabor income and a change of the marginal tax rate, a graphical representation of the model will be given[5].

First, consider Figure 2,where the curved line represents the production function. Note, that it runs from right to left: if the consumer is at point T, then all available time is spent on leisure. At point H, HT is spent on household production, at the expense of leisure. Between H and T the slope of the production function is larger, than the slope corresponding to the wage rate W_m (that is, $f' > W_m$). Therefore, between H and T it is more efficient to produce consumption through household production, than through paid labour and purchasing the goods on the market. But beyond H the consumer will work on the market, as his or her productivity there is larger, than his or her productivity at home. Now consider the following two outcomes. A consumer with preferences as indicated by the indifference curve in Figure 2 will supply labor on the market of the amount LH. In point E the marginal rate of substitution between leisure and consumption (S) equals the wage rate (W_m). But in Figure 3 a consumer with a relatively strong preference for leisure is depicted. Here the consumer will supply no labor on the market since the shadow wage of leisure is higher than the wage rate.

[5] Good illustrative explanations of the model can be found in Kooreman and Wunderlink (1997) and Bryant (1990).

Now consider a change in non-labour income V. In Figure 4 the consumer looses all its initial nonlabor income. Since such a change cannot be expected to change the relative prices of labor and goods in the market, or the basic parameters of the production function, it simply shifts the household's total budget line down in a parallel fashion.

FIGURE 2 INDIVIDUAL WITH STONG PREFRENCES FOR MARKET LABOR

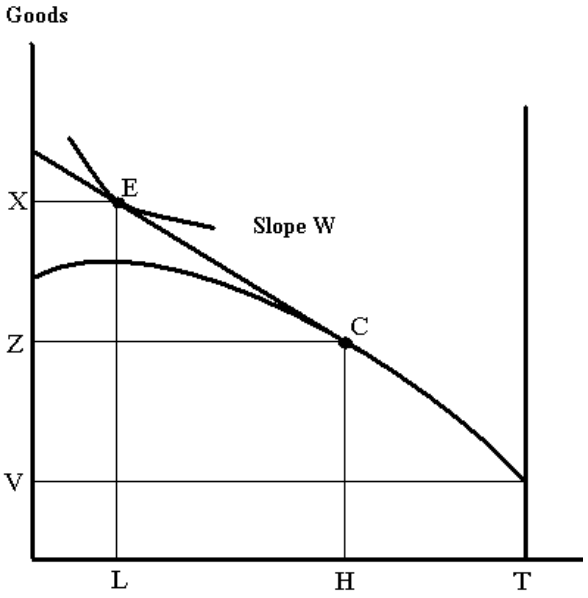


FIGURE 3 INDIVIDUAL WITH STRONG PREFERENCES FOR LEISURE

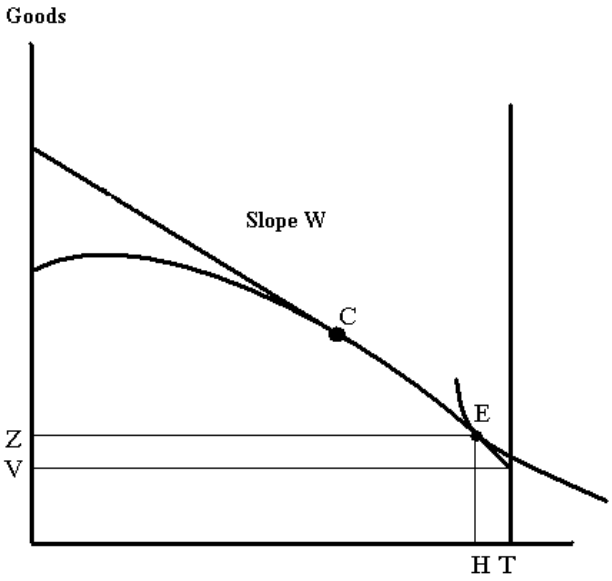


FIGURE 4 INDIVIDUAL WITH SHIFT IN NONLABOR INCOME

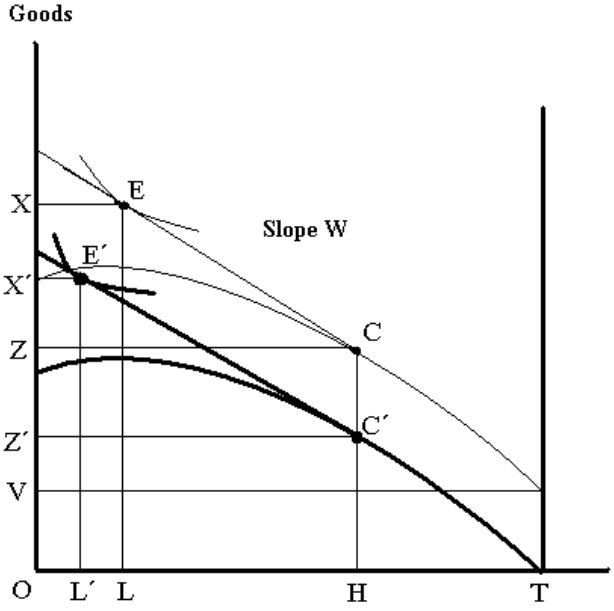
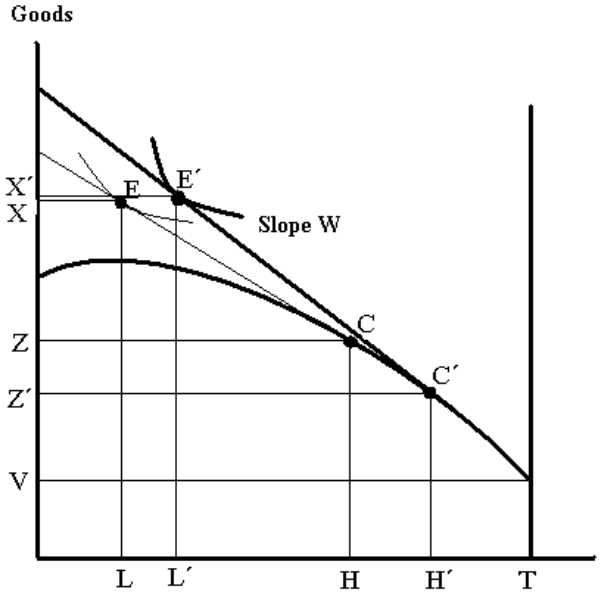


FIGURE 5 DECREASE IN THE MARGINAL TAX RATE ON LABOR INCOME



Consequently, the consumer's demand for goods and for leisure will decrease as long as both are considered as normal goods. The decrease in leisure means, of course, that the amount of time spent working will increase. As the decrease in V has no effect on the household production function, for individuals, who already supply labor to the market all the increase in work time will be in market work time. This change is represented by L´L in Figure 4.
However, for individuals as in Figure 3, who did not supply labour to the market before the drop in V, the change in work time will result in an increase of household labour supply. For large enough decreases in V they may even enter the labour market. An interesting prediction is, that if a sufficient number of commodities are inferior and time intensive, market time may decrease due to a decrease in non-labor income. To my knowledge this has not been tested yet, surely because of the unavailability of data about the intermediate goods entering the household production function. This latter result runs counter to the predictions of conventional labor supply models, where a drop in nonlabor income has an unambiguous effect on labor supply in the market. But what does empirical work say about the effects of a change in nonlabor income? Several studies confirm, that both males and females, married and single, devote less time to market work as nonlabor income rises. In a summary of female labor supply Heckman and Killingworth (1986) point to estimates of nonlabor income elasticities of around –0.23. As to the effects to household work Gronau (1977, Table 3) finds that an increase in nonlabor income of $1000 per year leads to a decline of 44 hours in the annual time spent in household work by white unemployed, married women. However, Kapteyn & Kooreman (1987, pp. 242-3) find that household work time of employed individuals is unresponsive to changes in nonlabor income. In general however, it seems that there exists a wide consensus, that for both men and women leisure is a normal, income-inelastic good.

Now let us consider the effect of a decrease in the marginal tax rate on time use. In Figure 5 the initial equilibrium point is E with HT hours spent on housework, LH hours spent on market work and the rest on leisure time. Since the wage rate is also the shadow price of leisure, a decrease in the marginal tax rate which increases the marginal wage rate results in an increase in the price of leisure. Therefore the individual will substitute market work for leisure. This is called the consumption substitution effect, since it increases the individual's total consumption. On the other hand, since an increase in the wage rate increases "market productivity" relative to household productivity, the individual will substitute market work for household work. This is called the production substitution effect and amounts in Figure 5 to

HH′. The total substitution effect of the own-wage-rate increase on market work, then, is the sum of the production substitution and the consumption substitution effects. However, so far I have not considered the fact that a rise in the individual's wage rate increases the household's real income. With the increase in real income increases the household's demands for goods and leisure, so long as both are normal goods. This is the income effect of the rise in the wage rate. The total own-wage-rate effect is thus the sum of the production and consumption substitution effects and the income effect, which can be either negative or positive depending on the ability of the income effect to offset the two substitution effects. Thus, the supply curve to the labor market can be positive or backward bending and negative.

The total own-wage-rate effect on household work is made up solely by the production substitution effect. As the wage rate rises the time spent in household work declines due to a shift of household to market production. Thus, a decline in the marginal tax rate on labor income should decrease the amount of household work done.

The total own-wage-rate effect on leisure is made of the consumption substitution effect and the income effect. As the price of leisure rises relative to goods, the household substitutes goods for leisure. As the rise in the wage rate increases real income, more leisure is demanded. Thus the effect of a decrease in the marginal tax rate on labor income on leisure is ambiguous, depending on which effect is stronger.

What evidence on these hypotheses was found by earlier studies? The summaries given by Pencavel (1986) for men and by Killingsworth and Heckman (1986) for women suggest that the total own-wage-rate effects on labor supply run in opposite directions for men and women. While males′ labor supply is mostly negative and inelastic in the neighborhood of –0.12, the evidence given by Killingsworth and Heckman (1986) reports positive elasticities for women. Thus females seem to increase the time spent in the market with an increased real wage rate, while men seem to have a backward bending labor supply curve. However, Flood (1987b) finds positive own-wage-rate elasticities for Swedish men, so the evidence is not clear-cut. For Norway Aaberge et al. (2000) find own-wage elasticities of 0.17 and 0.37 and cross-elasticities of –0.03 and –0.12 for males and females respectively.

As to the effects of wage rate changes on the household work of individuals, Gronau (1977) found that household work declines with increasing own-wage rates. This result is confirmed by Kapteyn and Kooreman (1987) and Flood (1987b) for females, while no effect can be found on the amount of household work done for males. Therefore, males′ household work seems to be unresponsive to changes in the marginal tax rate on labor income.

The study by Kapteyn and Kooreman (1987) also suggests that the effect of a change in the own-wage-rate on leisure in ambiguous. For both males and females an increase in the wage-rate increased time spent in entertainment and social activities, while it reduced time spent on sports or reading and watching TV.

The differences in the effects of wage-rate changes on males and females production activities and leisure are usually explained by the specialization of function and division of labor hypotheses[6]. Given that husband and wife are substitutes in household work, it simply states that each spouse should specialize in market or household work according to their comparative advantage. If the marginal productivity of time in household work is the same for both spouses and the wage rate the husband commands in the market is higher than the wife's wage rate, then the household will be able to consume more goods and services, if the wife specializes in household work and the husband in market work[7]. Such specialization implies that the household work of those specialized in market work will be less responsive to wage rate changes than the household work of those specialized in household work. Thus, the before mentioned evidence seems to be consistent with the specialization hypotheses.

Another interesting effect refers to cross-wage-rates. Consider an increase in the wage rate of the husband. First, the trade-off between her household production and her market work remains unchanged, so that her household production time use will not change. However, the amount of time she spends in market work will change depending on whether the spouses´ leisure times are complements of substitutes for each other. If they are complements then her leisure time will fall as his falls due to the substitution effect of a wage increase. If they are substitutes then she will substitute her leisure for his leisure as the substitution effect reduces his leisure time. Furthermore, the income effect of the rise in his wage rate will increase the demand for her leisure. The total effect on her leisure and market work will therefore depend on whether her leisure is a substitute for or complement of her husband's leisure and on the strength of the income effect.

For unemployed wives the increase in his wage rate effects only the division of her time between household work and leisure. The substitution effect will increase her leisure time and decrease her household work time, if her leisure is a substitute for her husband's, and

[6] See e.g. Bryant (1990), pp. 143-145.

[7] Since this is a static model, the long-run consequences of this optimal choice stay out of sight. By working in a household, one learns and becomes more and more experienced in household production. By working in the labor market, the productivity of paid labour increases, which will normally lead to an increase in wages, thus leading to a self-reinforcing specialization function. This may be one reason why , once unemployed, it can become increasingly difficult for women to enter the labor market.

inversely, if it is a complement. The income effect will increase the demand for her leisure and lower the time she spends on household work.

As to the empirical evidence of cross-wage-rate effects Gronau (1977) found that the employed married female's market work time falls, her leisure time rises, and her household work time remains unchanged, when her husband's wage rate increases. Kapteyn and Kooreman (1987) found the same results for women, indicating that their leisure is a gross substitute for their husbands´. However, they found also, that the husbands´ time use was much less responsive to changes in wives´ wage rates than wives´ time use to changes in husbands´, which can be seen once again as a confirmation of the specialization of function hypotheses.

Concluding the discussion of the effects of the Gronau model framework it can be said, that it makes the analysis of many testable economic hypotheses possible, which already have experienced confirmation in different studies.

2.2 Restrictions and extensions of the model framework

In the next step the restrictions of the model framework shall be discussed. The present model relies particularly on the assumption of the exclusion of joint production in the household production technology. Joint production occurs, if an activity serves a mixture of goals, or when two activities are done at the same time. For example, playing with children can be considered as a production activity, but for many parents it will be a leisure activity as well. Gronau´s model in fact excludes joint production. The exclusion of joint-production is quite counter-intuitive. Graham & Green (1984) estimated a version of the Gronau model in which they allowed for a type of joint production. In their model a household utility is determined by the level of consumption, and the level of effective leisure of the spouses. If the consumer enjoys direct utility from a household production activity, part of the time spent on home production can in fact be considered as leisure time. These hours plus pure leisure time, together form what is called effective leisure. The other part of the time spent on home production is called effective home production time input. Therefore, home production allows for a form of joint production. To consider the difference in possible predictions when allowing for joint-production consider the following example. A parent whose hourly wage exceeds the market price of one hour of child care has to choose between buying professional child care on the market and taking care of the child by himself. In the Gronau model the parent has two options to provide for child care. The first option is to take care of the child

himself at home. The second option is to earn money with his job and purchase child care on the market. In the model without jointness, the parent chooses the latter option. In the model with jointness, however, he will choose to take care of the child herself if a sufficiently large share of the time spent on this activity is valued as leisure.

While the jointness extension is an attractive one, it also raises the question of identifiability. Graham's and Green's (1984) model was not identified, so that they had to consider several special cases. One of these cases is for example non-jointness, which served as a sufficient restriction for the identification problem. Kapteyn and Kooreman (1987) argued this result would be due to the way in which joint production is introduced by Graham and Green into their model being fundamentally indistinguishable from a model without joint production. Furthermore earlier estimates of this type of models were not very successful[8]. Newer results, however, seem to be more promising, but are restricted to special cases[9]. It is because of this major problem of identifiability that strong assumptions have to be made to distinguish between differences in production technology and individual preferences, as has already been shown very early by Pollak et al. (1975). The consequence for the Gronau model is, that welfare is not affected by the composition of X, that is $\partial U / \partial X_M = \partial U / \partial Z$. As noted by Flood (1987a) the implication of this assumption is that the decision to buy goods on the market or to produce them at home will be based on productivity in home production and market wages and not on differences in preferences between market- and home produced goods.

Therefore market goods and home-made goods are here considered as perfect substitutes, what might be a quite unrealistic assumption. Evidently such substitutability exists. Consider table 1, which shows averages of time spent on market and household work and leisure for married employed and unemployed males and females from the current data set. The fact that individuals working in the market sector spend much less time working at home leads to the opinion that there is, in fact, substantial substitutability between market and non-market activities. In particular, individuals not working in the market sector do enjoy more leisure, on average, but the difference in much smaller than the difference in time spent in market work[10].

[8] See e.g. Kerkhofs (1991).
[9] See e.g. Kerkhofs and Kooreman (2002).
[10] In two studies Benhabib et al. (1990 and 1991) show that a simultaneous treatment of the market and home sector considerably improves the performance of their real business cycles models and helps to solve questions relating to productivity cycles.Their explanation relies heavily on the high elasticity of substitution between home and market goods.

Table 1 Time Use and Employment for all four surveys

Activity (hrs/wk)	Married Male		Married Female	
	Employed	Not Employed	Employed	Not Employed
MARKET WORK	41.85	6.13	27.97	2.56
Household Work	5.39	9.55	19.58	30.65
Leisure	38.05	54.03	36.42	41.68
Sleep and other	82.98	98.29	84.03	93.11

Additional evidence on substitutability, although not so clear cut, can be provided by the following table 2. There I have calculated hours of home and market work for a subsample of individuals in five wage groups. It can be clearly noted, that women substitute between time in the market and in home production as the wage varies. For men, however, the substitutability seems less evident[11].

TABLE 2 TIME USE AND WAGES

Averages (Work=hrs/wk)	Women					Men				
	Wage Group					Wage Group				
	1	2	3	4	5	1	2	3	4	5
Gross Wage Rate	91.81	119.40	139.09	160.42	178.26	102.80	121.04	140.54	160.69	198.65
MARKET WORK	14.75	18.46	18.17	21.65	26.34	39.20	44.99	35.77	36.66	38.01
Household Work	28.28	21.50	23.03	18.47	17.31	5.20	4.25	5.82	5.98	6.08
Total Work	43.03	39.95	41.19	40.11	43.64	44.40	49.24	41.59	42.64	44.09

Consequently, the assumption of perfect substitutability of home for market goods seems not only to arise from the necessity to assure identification and thus create issues of estimation and interpretation, but seems also to be backed by empirical data, especially in the case of females.

Another restriction of the model is, that it originally describes only a single person household, while later models emphasized the role of household production with two or more individuals.

[11] The wage groups in 1999 NOK were: 1=[0, 110], 2=[110, 130], 3=[130, 150], 4=[150, 170], 5=[170,300]

In general there are two different types of these models. In the first type it is assumed that the household is a single utility maximizing agent with the utility function

$$U = U(X, L^i) \qquad i = m,f$$

, where m and f stand for the male and the female partner respectively[12]. In these models each household partner has also his own household production function

$$Z^i = f^i(X_H^i, H^i) \qquad i = m,f$$

While one advantage of this model is its emphasis of the interaction between the partners´ choices, thus being able to make predictions about intrahousehold allocation of time and input resources, it has been criticized for its lack of microeconomic soundness. The reason for this is, that a multiperson household cannot be modelled as a single individual because it contradicts the neoclassical point of departure by which every individual should be characterized by his/her own preferences, as emphasized by Fortin and Lacroix (1997) and Kawaguchi (1994). One result of this so called "unitary model" is that the allocation of consumption and time are independent of the member of the household actually receiving the income. In this model, all incomes are pooled into the family's common budget. The underlying meaning of income pooling is, that there exists an altruistic family head that will neutralize any reallocation of intrahousehold income. In many empirical applications of the model by Fortin and Lacroix (1997) and Kawaguchi (1994) this prediction has been falsified, while a recent study by Aronsson et al. (2001) did not so[13].

The theoretical and empirical criticism of the unitary approach gave rise to collective household production models where each individual is characterized by his or her own utility function, specifically

$$U^i = U^i(X^i, l^i) \qquad i = m,f.$$

so that each spouse maximizes his/her own utility. This is the so called collective model approach used e.g. by Aronsson et al. (2001)[14].

Although the unitary and collective models give a better description of actual household behaviour by including the allocative and consumptive decisions of both spouses, their application is limited due to data availability reasons. They require accurate data on time-use

[12] See e.g Blundell and Walker (1986).

[13] In this study it is found that Swedish couples might choose to pool their sources of income into a family budget, since women´s earnings relative to their husband´s are rather equal as compared to men and women in other countries. It might thus make sense to pool income and share financial decisions.

[14] Another way of getting around the unitary framework is the use of a cooperative bargaining model within a game theoretical framework, see e.g. Daunfeldt (2001).

of both spouses not available in the data set analyzed in this study, since only one person per each household has been asked to keep a time-use diary.

Therefore and because of the problems of identification mentioned within the application of the Graham and Green model I will make use of the primordial Gronau modelling structure.

2.3 Empirical specification of the model

Now, let us get back to the empirical specification of the model. As pointed out by Gronau (1980, p. 409) the estimation of the home production function is difficult, since not only the amount of intermediate goods used for home production is unknown, but also it is impossible to separate which share of total household consumption stems from market and home produced goods. Hence he chooses an indirect approach by estimating the marginal productivity of time in home production. This approach is also applicated by Flood (1987b, p. 5).

It is assumed that:

$$S = \beta_s C + \gamma_h H + \gamma_n N + u_s \qquad (14)$$

$$f' = \beta_f C + \delta H + u_f \qquad (15)$$

where C is a vector of individual variables and u_s and u_f are error terms. If the indifference curves between leisure and consumption are assumed to be convex as in the graphical illustrations above, then γ_h and γ_n should be greater than zero. On the other hand it follows from the assumption of decreasing marginal returns, that δ in equation (15) should be negative.

Now I substitute (14) and (15) into (12):

$$H(S - f') = H(\beta_s C + \gamma_h H + \gamma_n N + u_s - \beta_f C - \delta H - u_f) = 0 \qquad (16)$$

$$\Leftrightarrow \quad H = \frac{\beta_f - \beta_s}{\gamma_h - \delta} C - \frac{\gamma_n}{\gamma_h - \delta} N + \frac{u_f - u_s}{\gamma_h - \delta} \qquad (17)$$

Substitution of (14) into (13) gives,

$$N(S - W_m) = N(\beta_s C + \gamma_h H + \gamma_n N + u_s - W_m) = 0 \qquad (18)$$

$$\Leftrightarrow \quad N = -\frac{\beta_s}{\gamma_n} C - \frac{\gamma_h}{\gamma_n} H + \frac{1}{\gamma_n} u_s + \frac{1}{\gamma_n} W_m \qquad (19)$$

Thus the following system of equations emerges:

$$H = \gamma_h^* N + \beta_h^* C + u_h^* \qquad \text{if RHS>0, otherwise H=0} \qquad (20)$$

$$N = \gamma_n^* H + \beta_n^* C + \gamma_w^* W_m + u_n^* \qquad \text{if RHS>0, otherwise N=0} \qquad (21)$$

with $\beta_h^* = \frac{\beta_f - \beta_s}{\gamma_h - \delta};\ \gamma_h^* = -\frac{\gamma_n}{\gamma_h - \delta};\ u_h^* = \frac{u_f - u_s}{\gamma_h - \delta};\ \beta_n^* = -\frac{\beta_s}{\gamma_n};\ \gamma_n^* = -\frac{\gamma_h}{\gamma_n};\ u_n^* = \frac{1}{\gamma_n};\ \gamma_w^* = \frac{1}{\gamma_n} W_m$

In order to estimate the current model two kinds of restriction must be placed. First, the system of equations has to be identified. Using the rank condition of identification I will simply delete one non significant C in (21), so that the rank condition is satisfied[15]. The second restriction deals with the right hand side endogenous variables and in this model it implies that $1 - \gamma_h^* \gamma_n^* > 0$ [16]. As pointed out by Flood (1987, p.7) this constraint can be interpreted in economic terms for this model. Since it was assumed that the consumption-leisure indifference curves were convex, so that $\gamma_h, \gamma_n > 0$, and since the marginal productivity in home production was assumed to be decreasing with respect to H, so that $\delta < 0$, it follows that $\gamma_h^* \gamma_n^* < 1$. and thus the constraint is satisfied.

3 The Data

3.1 Some remarks on time-use data

The data used for the estimation comes from four Norwegian time-use surveys from the years 1970, 1980, 1990 and 2000. These include rich information on individual and household characteristics of the person interviewed and a detailed time-use section on various market and non-market activities. The time-use data has been obtained by the use of time-use diaries the respondents had to fill out on two days of the week[17]. The respondents have been asked to write down their activities of the day in intervals of 15 min for the first three surveys and in intervals of 10 min in the last survey. In order to give an idea of the richness of information it should just be mentioned that these surveys distinguish between five main categories, such as market work, home work, personal care, education and leisure which are further itemized into 91 activities. Only a sample of these activities will be of interest for the present study.

Table 3 gives an overview over the time use categories and the single components they consist of. The highlighted, cursive activities will be subject to further analysis. The selection of household activities has been made on the believe that the selected activities constitute a possible alternative for market work. The classification provided in table 3 is not

[15] For an explanation of the rank condition see e.g. Greene (1993), pp. 589-594.
[16] See e.g. Amemiya (1974).
[17] In the 1970 survey a minor part of the respondents filled out the diarys on three different days during a week.

unproblematic, because no objective distinction between household work and leisure can be done. The distinction criterion applied by the time budget surveys is, that an activity that can be performed by someone else should be considered as household work. You can hire someone to do the cleaning and washing for you, but you cannot hire someone to do the entertainment or sport for you. This is the "third-person criterion" originally defined by Reid (1934). However, the distinction becomes less clear where productivity and personal enjoyment play both a possibly large role, i.e. in the case of joint production. Some people enjoy cooking, gardening or taking care of their children. They thus contain both elements of pleasure and work, making a classification more arbitrary.

TABLE 3 CLASSIFICATION OF ACTIVITIES

Classification 1	Classification 2	Classification 3
Market work	Income producing work[18]	Ordinary work in main occupation Overtime in main occupation Work in secondary occupation
	Time in connection to work	Meals at the work place Time spent at place of work either before or after work hours Other pauses
	Journey to work	Journey to work
Household Work And family care	Housework	***Food preparation, setting of table, serving, Dish washing***
		House cleaning
		Washing and ironing
	Maintenance	Construction. Larger remodelling Painting, smaller remodelling Maintenance and repair of dwelling and household equipment Maintenance and repair of other equipment
	Gardening	Care of garden, lot, and animals
	Work with children	Childcare and help to children Help with school work Other work with children
Leisure	***Leisure***	Sport and outdoor recreation Entertainment Socializing Radio and television Reading Other leisure Travel in connection to leisure time activities

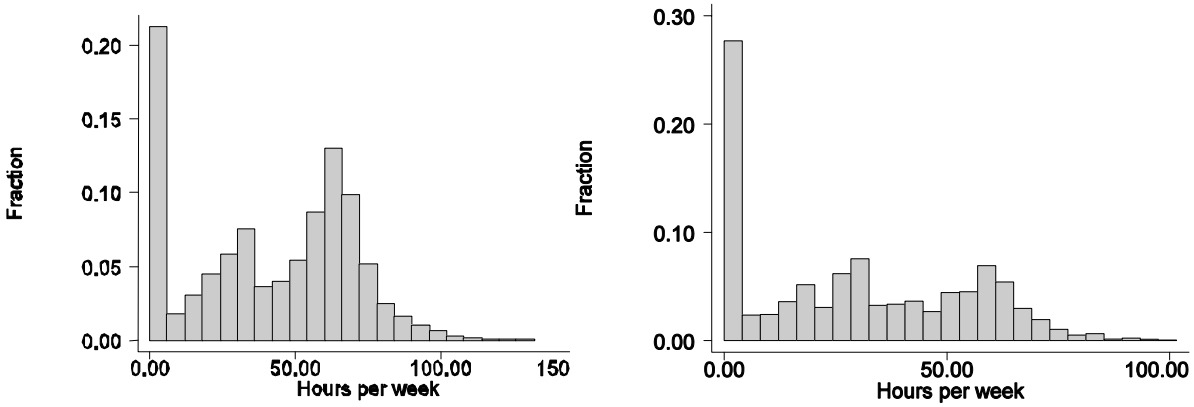
Before going into a more detailed description of the individual characteristic variables used in the analysis, it is important to note some particular characteristics of time-use data in general.

[18] For the years 1970-1990 this subcategory included also the activity: Agriculture, forestry and fishing on own property/boat. This has been taken out of the analysis since it was not included in the year 2000 time-use data and since it amounted to only a few minutes of time-use per week in the foregoing surveys.

Juster and Stafford (1991) report a number of validity tests carried out in 1975-76 on an early time use study for the U.S. Those tests suggest that the time diary method is much more accurate, than survey questions asking for typical time use. Further they are a little more accurate than using an electronic paging device, which randomly activates the recording of a time-use activity when receiving a signal.

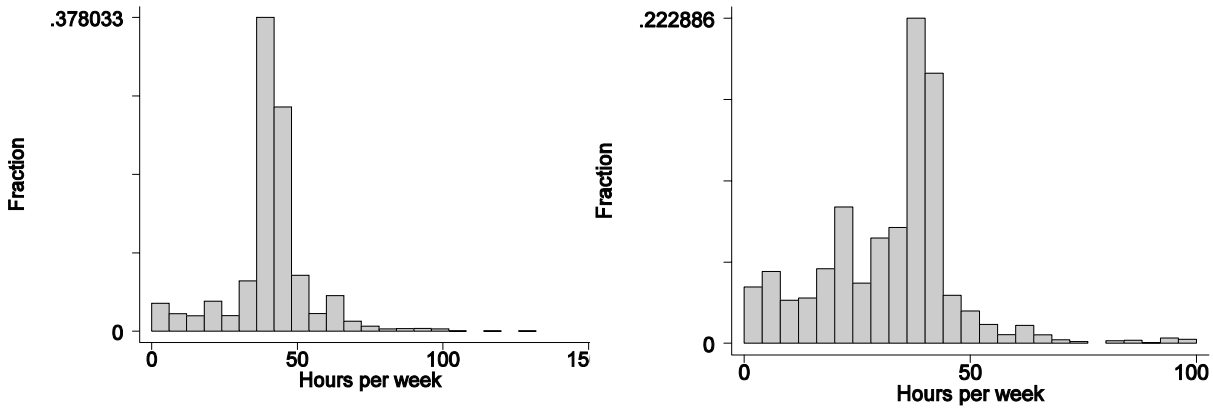
An example of this accuracy can be given by a comparison of differences between data based on questions about current hours per week including overtime and secondary jobs ("survey data") and time-use data from the same samples of people. As can be seen in figures 6 and 7 the time-use data distributions are much smoother and have a larger variance. One explanation for this is that many respondents may report their contracted number of hours disregarding or forgetting any nonwork episodes at work and any irregular overtime work. Even if asked explicitly about secondary work it might also be difficult for them to report hours retrospectively, in particular if the respondent only works intermittently in this job. Another reason is the noisiness of the data due to the fact that only a few days are observed for each respondent[19]. Further inspection of the two figures reveals that the proportion of zeros reported in the time-use data is much higher, than that in the survey. This stems from the fact that time-use data are usually only collected for two different days during the week. Since market labor supply is not equally distributed during the week this results in the observation of "wrong" zeros and might lead to the wrong conclusion of the zero´s outcome being a response of the individual's deliberate choice.

FIGURE 6 TIME-USE DATA FOR MEN AND WOMEN IN 1970-2000



[19] See Klevmarken (1999), pp. 4-5.

FIGURE 7 SURVEY DATA FOR THE SAME INDIVIDUALS IN 1970-2000



Thus, someone who usually works five days a week, eight hours per day could come up with zero hours of work reported, because he took off to take care of his sick daughter. The high frequency of observed zeros in time-use data is even more understandable when considering more episodic activities as repair or house maintenance. Once decided to participate in these activities they usually necessitate a relatively huge amount of time-use, so that the observed variance in these activities may be very strong. Thus, in general time-use data will produce a distribution among households that has far too many cases with a zero value and far too many with vary large values[20]. Therefore it will be necessary for the estimation procedure to find out possibly "wrong" zeros in order to avoid biased estimation results. This will be dealt with in Chapter 4.2 with the introduction of the double-hurdle model.

Another problem is connected to the unequal distribution of activities during weekdays and weekends. In order to construct a synthetic week a weighted average using the weights 5 and 2 has been calculated depending on whether the time-use day is a week day or a weekend day. Summarizing the discussion of the characteristics of time-use data it can be said, that time-use data give a better picture on actual, than on average time-use, because individual variation in time-use is still contained, while in survey data it is simply averaged.

[20] See Juster and Stafford (1991), pp.481-486.

3.2 The current data set

Table 4 and table 5 give an overview over the means and standard deviations of the dependent and independent variables used in this study. First, the effective sample size used in this study and the number of persons, who originally completed the time-use diaries and the interview shall be considered. There are several reasons for the reduction of the sample size.
First, all individuals below the age of 16 and above the age of 65 have been deleted because everyone in the sample size should at least have the possibility to join the labor force. Second, only married couples have been included, because of the special interest of this study in cross-wage elasticities of labor supply of the spouse. Third, some observations have been deleted because of the low quality of the answers to the time-use or survey questions.
Further inspection of the time use in paid and unpaid work reveals some interesting facts. While the total number of work at home and in the market is quite the same for men and women, the sexes´ composition and trends of paid and unpaid work are inverse. In 1970 men spend more than double as much time as women for paid work but only about $1/7$ of womens´ time for home work. This inequality in the distribution between paid and unpaid work declined subsequently in the following decades with men doing less market and more home work, while the trends for women were inverse. However, in the year 2000 men and women still seem to have quite different work patterns with women spending more than double as much time as men for home work and only about 70% of the amount of men for market work.

Another fact is the still gender related distribution of different responsibilities within the single household activities. Men spend more time in maintenance and gardening, while women's main tasks remain to be cleaning, washing, preparing meals and taking care of children. Another trend can be observed in the development of the shares of household activities within household work. Childcare takes a larger share of household work today than 30 years ago, while the share of cleaning and washing declined over the same period.
Next, I will discuss the variables that have been used to explain the allocation of time in the market, work at home in general, its particular components and finally leisure.

TABLE 4 DESCRIPTIVE STATISTICS OF VARIABLES FOR THE YEARS 1970 AND 1980

	1970				1980			
	Men		Women		Men		Women	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Original Sample Size	1464		1578		1576		1712	
Effective Sample Size	791		1033		827		996	
Age	**38.58**	16.07	**39.07**	14.27	**38.05**	15.96	**38.43**	15.82
Years of Education	**9.80**	2.33	**9.17**	2.02	**9.77**	2.71	**9.72**	2.52
Gross wage rate	**141.01**	39.30	**98.77**	21.80	**135.30**	46.31	**126.58**	21.11
Marginal wage rate	**72.57**	13.52	**68.49**	11.71	**70.86**	18.74	**87.67**	17.93
Marginal tax rate	**46.88**	7.03	**29.69**	8.15	**45.24**	9.47	**30.49**	10.11
Nonlabor income	**35844**	54654	**26045**	54344	**32533**	47329	**17121**	43592
Spouse's marginal wage rate	**64.12**	17.02	**71.23**	11.02	**68.35**	8.7	**76.34**	9.8
Centrality	**2.36**	1.01	**2.45**	1.05	**2.44**	1.11	**2.43**	1.14
Household Members	**3.29**	1.66	**3.15**	1.75	**2.99**	1.58	**2.89**	1.61
Children 0-2	**0.14**	0.35	**0.15**	0.35	**0.09**	0.29	**0.09**	0.29
Children 3-6	**0.22**	0.41	**0.22**	0.42	**0.14**	0.35	**0.14**	0.35
Children 7-12	**0.29**	0.46	**0.34**	0.47	**0.20**	0.40	**0.21**	0.41
Children 13-17	**0.34**	0.71	**0.33**	0.68	**0.17**	0.37	**0.18**	0.39
Childcare help	**0.04**	0.21	**0.05**	0.22	**0.10**	0.30	**0.11**	0.31
Household help	**0.04**	0.19	**0.05**	0.22	**0.07**	0.25	**0.05**	0.22
Housetype	**0.44**	0.50	**0.44**	0.50	**0.56**	0.50	**0.52**	0.50
Car	**0.66**	0.47	**0.66**	0.47	**0.83**	0.37	**0.78**	0.41
Leisure House	**0.24**	0.43	**0.25**	0.43	**0.31**	0.46	**0.34**	0.47
Time Use Categories								
Market work	**45.51**	29.15	**12.33**	22.97	**33.76**	29.01	**15.45**	22.74
Household Work	**4.44**	7.13	**33.19**	16.34	**6.67**	7.88	**23.08**	12.63
Preparing Meals	**1.23**	2.31	**11.41**	6.20	**2.09**	2.80	**8.03**	5.05
Cleaning	**0.86**	2.32	**7.75**	5.39	**1.64**	3.15	**7.04**	5.36
Washing	**0.15**	0.82	**4.24**	4.19	**0.28**	1.30	**2.82**	3.08
Gardening	**1.76**	3.93	**1.34**	3.17	**1.58**	3.50	**1.21**	2.71
Maintenance	**1.93**	6.60	**0.22**	2.30	**3.27**	7.22	**0.54**	2.63
Childcare	**0.76**	1.77	**4.65**	6.93	**1.32**	2.60	**3.49**	5.62
Leisure Time	**34.78**	19.36	**34.29**	17.49	**42.00**	19.90	**40.05**	16.27

TABLE 5 DESCRIPTIVE STATISTICS OF VARIABLES FOR THE YEARS 1990 AND 2000

	1990				2000			
	Men		Women		Men		Women	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Original Sample Size	1468		1613		1730		1678	
Effective Sample Size	602		789		621		676	
Age	**37.29**	13.81	**36.82**	13.26	**40.35**	14.13	**40.61**	13.79
Years of Education	**11.31**	2.70	**11.18**	2.64	**11.72**	2.60	**11.46**	2.76
Gross wage rate	**134.66**	38.64	**96.93**	22.78	**177.02**	51.87	**143.24**	29.31
Marginal wage rate	**75.65**	15.67	**65.99**	13.37	**102.86**	26.50	**90.80**	17.60
Marginal tax rate	**41.79**	8.69	**30.94**	7.61	**40.83**	5.16	**36.32**	3.30
Spouse's marginal wage rate	**64.32**	19.24	**73.24**	18.99	**89.26**	15.69	**97.35**	15.19
Nonlabor income	**52288**	177002	**24633**	61124	**61931**	120041	**44019**	82546
Centrality	**2.49**	1.14	**2.49**	1.15	**1.85**	1.30	**1.74**	1.32
Household Members	**2.80**	1.46	**2.78**	1.50	**2.44**	1.48	**2.45**	1.46
Children 0-2	**0.10**	0.31	**0.12**	0.33	**0.10**	0.30	**0.12**	0.33
Children 3-6	**0.12**	0.33	**0.15**	0.36	**0.14**	0.35	**0.16**	0.37
Children 7-12	**0.14**	0.35	**0.20**	0.40	**0.19**	0.39	**0.20**	0.40
Children 13-17	**0.15**	0.35	**0.19**	0.39	**0.18**	0.38	**0.18**	0.38
Childcare help	**0.12**	0.33	**0.17**	0.38	**0.16**	0.36	**0.20**	0.40
Household help	**0.03**	0.18	**0.04**	0.20	**0.04**	0.20	**0.03**	0.18
Housetype	**0.60**	0.49	**0.59**	0.49	**0.60**	0.49	**0.57**	0.50
Car	**0.88**	0.33	**0.87**	0.33	**0.92**	0.28	**0.91**	0.29
Leisure House	**0.33**	0.47	**0.30**	0.46	**0.38**	0.49	**0.41**	0.49
Time Use Categories								
Market work	**35.95**	29.09	**21.57**	24.06	**34.37**	30.74	**23.87**	26.09
Household Work	**5.95**	6.04	**18.31**	10.13	**6.57**	6.32	**16.38**	9.16
Preparing Meals	**2.10**	2.43	**6.45**	4.20	**2.84**	2.86	**6.44**	4.09
Cleaning	**1.74**	3.01	**4.77**	4.19	**1.05**	1.43	**2.59**	2.19
Washing	**0.25**	1.03	**2.69**	2.64	**1.68**	2.73	**4.25**	4.18
Gardening	**1.01**	2.40	**0.97**	2.19	**1.66**	3.35	**1.04**	3.00
Maintenance	**2.79**	6.21	**0.45**	2.24	**2.22**	5.70	**0.26**	2.43
Childcare	**1.77**	3.24	**4.12**	7.13	**1.72**	3.45	**3.15**	7.04
Leisure	**41.36**	19.04	**38.92**	17.15	**42.29**	20.76	**41.74**	18.58

From table 4 and 5 it follows that in all years men have a higher gross wage rate than women, although the gap between these wages dropped in time. For all years this gap is smaller or even negative - meaning that women have a higher wage rate – when considering the marginal wage rates. This is due to higher marginal taxes men on average have to pay on their higher income. The marginal wage rate has been defined as $\hat{W}_m = W(1-\hat{t}_m)$, where W is the gross wage rate and $\hat{t}_m$ is the estimated marginal tax rate. The original marginal tax rates have been obtained from Statistics Norway (1984 and 1991) and Noor (2000). These include social security contributions and child allowances. But it is necessary to estimate the marginal tax rates because of their possible endogeneity to the number of hours worked on the market. The estimation procedure will be dealt with in chapter 4.1. Since gross wage rates could not be obtained from the surveys directly, an indirect standard procedure of wage estimation has been used, also described in chapter 4.1.

In order to enable the comparison of the wage rates through time the income variables from the first three studies have been inflated up to the year 2000 using the CPI inflator[21]. A major problem of the correct assignment of marginal tax rates to individual income was the rather poor data on income variables of the first three surveys. For the year 1970 only net total individual and household income was available, while in the following two surveys the gross total individual and household income was given. In all three studies no differentiation has been made between labor and nonlabor income. Therefore an assumption had to be made in order to be able to divide the total income values into a labor and a nonlabor income share. The assumption has been made on the basis of the year 2000 survey that included detailed data on different income sources, so that exact labor and nonlabor income shares have been available. For this year an average nonlabor income of 7,17% on the basis of total individual income has been calculated. In the following this average has been assumed to be valid for the earlier studies, so tha the other labor and nonlabor income shares have been calculated on the basis of this assumption.

An additional step had to be taken for the 1970 survey, since here only net income variables have been given. In order to obtain gross income values the inverse tax code has been used, afterwards the resulting gross income values have been divided into the corresponding labor and nonlabor income shares.

[21] The information has been taken from the UN Statistical Yearbook (1979/89 and 1993) and OECD´s Main Economic Indicators (April 2001).

Although this method may yield a poor approximation of real gross labor income for individual households, it should yield accurate results on the average, if the shares of labor and nonlabor income have not changed significantly during the last 30 years.

The nonlabor income depicted in the two tables is the sum of the nonlabor incomes of both spouses.

Apart from the wage and income variables other socioeconomic variables have been included in the estimation in order to be able to isolate the tax effects and because the effects of these variables are interesting in themselves. These variables include age, years of education, the number of household members, the number of children, dummy variables for children in the age brackets of zero to two, three to six, seven to thirteen and thirteen to seventeen years old with the value 1 if a child in the age bracket is present in the household and 0 else.

Tables 4 and 5 show, that for both genders the average years of education have increased for about three years with men in the year 2000 still having slightly more years of education than women. The tables show also that the average number of household members and children has decreased over the years, although this trend has come to a halt in the year 2000 when children are considered.

Similar as in Flood (1987a and 1987b) I have also included some variables that measure different kinds of commitments. These dummy variables are housetype, indicating that someone lives in an "enebolig", i. e. a freestanding one-family house. I have further included a dummy variable indicating the ownership of a car and the ownership of a leisure house. All these variables are increasing over the period of analysis. The next two dummy variables are called "household help" and "childcare help", indicating that someone has hired a person not included in the household in order to do household work or take care of the children. While surprisingly it does not seem that more people nowadays hire household help – the average numbers for the years 1970 and 2000 are around 4% of all households - , it is evident that a much higher percentage of individuals take the opportunity of childcare help today than 30 years before. While only 4% used childcare help in 1970, already 20% of all households admitted to take advantage of this service in the year 2000.

The next variable used in the analysis is named centrality. It takes the value four if someone lives in a densely built community with more than 100000 citizens, three if the community has between 20000-100000 citizens, two for densely built communities with less than 20000 inhabitants and one for small communities with a very low population density. We see that in the year 2000 more people lived in densely populated areas than before. The last variable, called "year", is only relevant for the pooled estimations. It is controlling for the year a

particular observation comes from, taking the values 1 to 4 for the years 1970 to 2000 respectively.

4 The estimation procedure

4.1 Estimation of wage and income variables

As already mentioned the survey did not report any direct wage rate information, so that wage rates have been calculated using the following estimation procedure. First total gross income has been divided by the amount of annual hours worked for those who reported to have a job during the time of the survey. However, since the only information available from the survey concerning the hours of work on the market is the weekly average, the assumption has been made that the average worker worked 52 weeks in year 1970 and one week less in each next decade. This resulted in averages of annual hours worked of 1612, 1550, 1435 and 1440 for the years 1970, 1980, 1990 and 2000 respectively. These averages do not differ widely from official numbers with 1600, 1512, 1432 and 1375 annual hours worked per person for the same years[22].

The resulting division of gross labor income with the estimated annual hours worked yields the gross wage per hour. In order to get better estimates of gross wage rates for those already employed and to get potential wage rates for those not having a paid job at the time of the survey, I followed a standard procedure of constructing a wage equation on the basis of those households reporting a positive number of hours worked in the market and a positive labor income. This procedure is called the Heckman procedure[23] and has been used in the following to estimate the gross wage rates of both spouses.

The Heckman procedure makes first an attempt to correct for selectivity bias. This can be done by running a probit equation explaining, if an individual has got a paid job or not. Next, the equation of interest has to be estimated using OLS, where $\hat{\lambda}$ - the inverse Mills ratio estimated from the probit equation – must be included in order to avoid the specification error of an omitted variable. In order to fulfil the conditions of identification for this simultaneous-

[22] See e.g. Key indicators of the Labour Market: 2000-2001, Geneva, International Labour Office.
[23] See e.g. Maddala (1983), pp. 708-711.

equations model there must be at least one variable in the probit equation, that is not included in the second equation[24]. The following specification of the equation system has been used:

$$\left.\begin{aligned} W &= cons_1 + \beta_1 AGE + \beta_2 AGE^2 + \beta_3 EDU + \beta_4 EDU^2 + \beta_5 EXP + \hat{\lambda} + \varepsilon_1 \\ W_P &= cons_2 + \gamma_1 AGE + \gamma_2 AGE^2 + \gamma_3 EDU + \gamma_4 EDU^2 + \gamma_5 EXP + \gamma_6 NUMBCH + \varepsilon_2 \end{aligned}\right\} \text{if}$$

$$W_p > 0$$

$$W = W_p = 0 \text{ otherwise}$$

where W_p is a dummy variable equal 1 if W>0 and $W_p = 0$ otherwise, W is the log of the gross wage rate, EDU is education in years and EDU² its squared value, EXP is a proxy variable for labor market experience generated as AGE minus EDU minus 6 and $cons_1$ and $cons_2$ are constants. In the following tables 6 and 7 only the results from the second step regression, i.e. the OLS-Regression, are presented.

TABLE 6 ESTIMATION OF GROSS WAGES USING HECKMAN´S TWO-STEP ESTIMATION PROCEDURE

	CONS	AGE	AGE²	EDU	EDU²	EXP	$\hat{\lambda}$
Female							
1970	**4.12**	**1.48**	**-.00001**	**.071**	**.063**	**-1.57**	**-.345**
	(9.39)		(-3.19)				(0.024)
1980	**4.48**	**.025**	**-.00023**	**0.905**	**0.006**	**1.01**	**-.985**
	(7.77)			(1.99)		(2.01)	(-2.75)
1990	**2.83**	**.089**	**-.00093**	**-.183**	**0.003**	**0.06**	**-.049**
	(8.29)	(6.94)	(-6.07)		(2.44)	(1.96)	
2000	**3.76**	**.061**	**-.00056**	**.345**	**-.096**	**-0.0246**	**-.234**
	(9.15)	(4.11)	(-3.15)	(2.53)	(-3.20)		
Male							
1970	**3.47**	**0.097**	**-.00054**	**.056**	**-.075**	**0.564**	**-.298**
	(6.76)	(2.81)	(-2.30)		(1.97)	(3.97)	
1980	**3.37**	**.055**	**-.00062**	**0.073**	**-0.002**	**0.0087**	**-.210**
		(4.43)	(-4.28)		(9.10)		
1990	**3.25**	**.072**	**-.00068**	**0.052**	**0.042**	**0.103**	**-.471**
	(6.69)	(3.61)		(2.18)	(2.20)		(-2.32)
2000	**3.03**	**.098**	**-.00095**	**0.159**	**-0.0003**	**0.106**	**-.476**
	(6.35)	(6.08)	(-4.78)	(1.99)		(3.21)	

Where t-values are presented in parentheses if significant on 5% level

[24] For further details see Heckman (1979) or Greene (1993), pp. 708-711.

The results from both tables show, that the gross wage rate is in most cases a positive function of age, years of education and labor market experience with decreasing marginal effects for age and years of education.

TABLE 7 ESTIMATION OF GROSS WAGES OF THE SPOUSES USING HECKMAN´S TWO-STEP ESTIMATION PROCEDURE

	CONS	AGE	AGE²	EDU	EDU²	EXP	$\hat{\lambda}$
Female							
1970	**-1.80**	**-0.029**	**0.00035**	**0.745**	**-0.712**	**0.034**	**1.11**
				(1.98)	(-1.94)		(2.02)
1980	**3.22**	**-0.48**	**0.0053**	**0.179**	**-0.14**	**0.051**	**-0.213**
	(3.38)	(-2.24)	(2.17)			(1.94)	
1990	**2.95**	**0.016**	**0.0002**	**0.0068**	**0.0135**	**-0.0001**	**-0.091**
	(4.97)		(1.94)	(1.99)			
2000	**2.98**	**0.005**	**0.00003**	**0.0495**	**-0.024**	**0.98**	**0.66**
	(2.37)	(2.44)		(1.96)		(2.43)	
Male							
1970	**2.30**	**0.37**	**-0.004**	**0.087**	**-0.06**	**0.93**	**0.098**
	(4.54)	(3.58)	(-3.70)			(2.01)	
1980	**4.79**	**0.058**	**-0.005**	**0.093**	**0.14**	**1.003**	**-2.13**
	(1.83)	(2.34)		(2.01)		(2.00)	
1990	**3.07**	**0.07**	**-0.00006**	**0.0137**	**0.0028**	**0.33**	**-0.15**
	(7.27)	(1.96)		(2.34)		(2.21)	
2000	**4.044**	**0.06**	**0.00005**	**0.027**	**-0.0021**	**0.67**	**-0.29**
	(6.29)			(1.98)		(2.569)	

Where t-values are presented in parentheses if significant on 5% level

The next problem is connected to the possible endogeneity of the marginal tax rates. Since marginal tax rates vary with the hours worked in the market and the labor income, they might be endogenous to the hours worked in the market. In order to address this possible endogeneity problem, marginal tax rates will be estimated using an instrumental variable method, where all exogenous variables will be used as instruments. This has been shown to yield the best estimates of the dependent variable[25]. However, in addition to the regression estimates of the instrumental variable method some specification tests have been used. These are the RESET test, which performs the Ramsey (1969) regression specification error test for omitted variables with the null hypotheses of no omitted variables, the Breusch-Pagan Test

[25] See Maddala (1983), pp. 228-234.

(HET) for heteroscedasticity with the null hypotheses of homoscedasticity and the Kolmogorov-Smirnov Test (SKTEST) of normality of the distribution of the residuals[26]. Some selected results are shown in Table 8. Since some estimates of the OLS regression did not pass the RESET test, modifications of the prior model specification have been considered, so that the RESET test could not be rejected at least at 1 per cent significance level like in the case of male respondents in the year 2000. In addition to that the results presented in table 8 revealed some form of heteroscedasticity and non-normality. Therefore a robust regression with heteroskedastically consistent robust standard errors has been performed. The regression causes the Huber/White sandwich estimator of the variance to be used in order to generate consistent standard errors even when the data are not i.i.d[27].

TABLE 8 DIAGNOSTIC RESULTS OF THE ESTIMATION OF $\hat{t}_m$

	Female 1990	Male 2000
R^2	0.2521	0.3429
RESET	0.93	3.33
p-value	0.4256	0.0190
HET	107.29	164.01
p-value	0.0000	0.0000
SKTEST (p-value)	0.0000	0.0000

Using the estimated marginal tax rates from the robust estimator equations, the $\hat{t}_m$ have been predicted and finally $\hat{W}_m = W_m(1-\hat{t}_m)$ has been calculated.

Using these estimates the simultaneous equations model could be estimated using a two-stage method[28]. In the first step the reduced form of (20) and (21) have been estimated using a ML procedure, where the reduced forms are

$$H = \frac{\gamma_h^*}{1-\gamma_h^*\gamma_n^*}(\beta_h^* C + u_h^* + \gamma_w^* W_m + u_n^*) + \frac{1}{1-\gamma_h^*\gamma_n^*}(\beta_h^* C + u_h^*) \qquad (22)$$

$$N = \frac{\gamma_n^*}{1-\gamma_h^*\gamma_n^*}(\beta_h^* C + u_h^*) + \frac{1}{1-\gamma_h^*\gamma_n^*}(\beta_n^* C + \gamma_w^* W_m + u_n^*) \qquad (23)$$

Next the predictions of N and H have been calculated. Using these predicted values as instruments, equations (20) and (21) have been estimated using the estimation procedure described in the next chapter.

[26] For a description of the test see Maddala (2001), pp.202-205.
[27] See White (1980).
[28] See Maddala (2001), pp.360-381.

4.2 The double-hurdle model

The problem already being introduced in chapter 3.1, that time-use data often exhibit censoring at zero, had to be considered in the empirical specification of the model. Usually this obstacle is handled with a Tobit model[29]. The basic assumption in this model is that observed zeros are all the outcome of optimal choice, meaning that they can only arise, if the individual decides not to participate in the labor market or in a certain household activity. However, as already described earlier, time-use data may also report "wrong" zeros that had to be considered in further estimation. Formally the Tobit model can be written as

$$y_i^* = x_i \beta_1 + \varepsilon_1 \tag{24}$$

$$y_i = \begin{cases} y_i^* & \text{if } y_i^* > 0 \\ 0 & \text{else} \end{cases} \tag{25}$$

$$\varepsilon_1 \sim N(0, \sigma^2) \tag{26}$$

where y_i^* is the unobserved latent value, i.e. desired hours of work, y_i is the actual observed outcome, x_i is a vector of explanatory variables which is assumed to be uncorrelated with the error term ε_1 and β_1 is a vector of unknown parameters.

The log likelihood function for the Tobit model is

$$\ln L = \sum_{y_i>0} -\frac{1}{2} + \left[\ln(2\pi) + \ln \sigma^2 + \frac{(y_i - \beta_1' x_i)}{\sigma^2} \right] + \sum_{y_i=0} \ln \left[1 - \Phi \left(\frac{(\beta_1' x_i)}{\sigma^2} \right) \right] \tag{27}$$

where Φ is the probability density function of the standard normal distribution. The two parts of the log likelihood correspond to the classical regression for the nonlimit observations and the relevant probabilities for the limit observations.

Since this model does not separate an individual's participation decision from the decision of the amount of time to be invested in a particular activity, it might be considered as rather restricted due to the particular data-collection method with time-use data. In order to distinguish between the true zeros of deliberate choice and false zeros due to the data collection method, Cragg´s (1971) double-hurdle model will be introduced, which might be seen as an extension of the Tobit model.

[29] For the original formulation see Tobin (1958).

Formally it is represented in the following way:[30]

1. Participation equation:

$$\text{Prob}\left[y_i^* > 0\right] = \Phi\left(\lambda' x_i\right) \tag{28}$$

$$\text{Prob}\left[y_i^* \le 0\right] = 1 - \Phi\left(\lambda' x_i\right) \tag{29}$$

$$d_i = \begin{cases} 1 \text{ if } y_i^* > 0 \\ 0 \text{ if } y_i^* \le 0 \end{cases} \tag{30}$$

2. Structural equation, which is the regression equation for the nonzero observations:

$$E\left[y_i \middle| d_i = 1\right] = \beta' x_i + \sigma\lambda_i \tag{31}$$

As can be seen, the model specifies two steps in order to observe a positive y_i. First, a positive amount of hours worked has to be desired ($y_i^* > 0$). Second, the person must be observed working on the interview day ($E\left[y_i \middle| d_i = 1\right]$). This is a combination of a truncated regression model and a univariate probit model. The tobit model, as presented above, arises if $\lambda = \beta / \sigma$. The parameters of the participation equation can be estimated independently using a truncated regression model[31].

Now there exists a simple test for the double-hurdle model against the Tobit model. It can be shown, that the Tobit log-likelihood is the sum of the log-likelihoods of the truncated and the probit models. Therefore, one simply has to estimate the truncated regression model, the Tobit model and the probit model separately and use a likelihood ratio (LR) test. The LR statistic can be computed using

$$\Gamma = -2\left[\ln L_T - \left(\ln L_P + \ln L_{TR}\right)\right] \sim \chi^2{}_k$$

where

L_T = likelihood for the Tobit model

L_P = likelihood for the probit model

L_{TR} =likelihood for the truncated regression model

and k is the number of independent variables in the equations. If the test hypothesis is written as

$$H_0 : \lambda = \beta / \sigma \qquad\qquad H_1 : \lambda \neq \beta / \sigma,$$

[30] See e.g. Greene (1993), pp.700-701.

[31] The assumption of independancy between the participation and the structural equation is only one variant of a possible extension of the tobit model. For specifications where this assumption has been dropped see, e.g. Carlin and Flood (1997). This unrestrictive version of the Cragg model can however not be tested by the author, as it is not included in standard statistical software and as the author´s programming capabilities are rather restricted.

then H_0 will be rejected on a prespecified significance level, if $\Gamma > \chi^2_k$.

There have already been several applications of the double-hurdle model and some modifications of it. Deaton and Irish (1984) used the model in a consumption study, where it was hypothesized that too many people reported zero expenditures for liquor and tobacco in fear of being stigmatized. But the model has also been used to labor supply studies, e.g. in Carlin and Flood (1997) or Daunfeldt (2001). In all cases the double-hurdle model was preferred over the more restrictive Tobit model, which corroborates the fact that many of the reported zeros in time-use data stem from the method of data collection and not from deliberate individual choice.

5 The estimation results

5.1 Effects of taxes, wages and income variables

Due to a very low availability of positive observations of maintenance activities for women and washing activities for men, no regressions could be performed for these activities with respect to the particular sex. On average there were only 48 positive observations for women doing maintenance activities and 112 positive observations for men in washing activities. Further, also women's gardening and men's cleaning activities had to be excluded, because the estimation results were not reliable. This may be due to the highly irregular character of these activities for the particular sex, due to the special characteristics of time-use data.

For all other activities the following results have been found.

In a first step the restriction imposed by the Tobit model has been tested against the double-hurdle model. This has been done by performing LR-Tests described earlier in the text. Comparing the LR-statistics with the critical value $\chi^2_{20} = 37.6$ at the 1% level, the restrictive Tobit model could be rejected in all cases. Because the rejection of the Tobit specification was so strong, I do not present a complete table of the LR-test results, but confine myself to the exemplary presentation of one calculation, namely the case of female market labor supply for the year 1970.

The log likelihood obtained the following values in this case:

$\ln L_T =$ -2150.82 $\quad \ln L_P =$ -445.28 $\quad \ln L_{TR} =$ -1677.37

Thus

$$\Gamma = -2\left[\ln L_T - \left(\ln L_P + \ln L_{TR}\right)\right] = -2\left[-2150.82 - (-445.28 - 1677.37)\right] = 56.34 > \chi^2_{20} = 37.6,$$

So that H_0 could be rejected.

Due to the strong rejection of the Tobit model in all cases, the observed zeros could not be regarded as the outcome of deliberate choice and a model had to be considered, which differentiated between the switch from zero to positive values and the subsequent decision of time allocation. Thus, in the following only the results from the double-hurdle model will be presented.

The results from the first hurdle estimation, indicating that a positive value is observed, yielded mostly non-significant results and are therefore not presented here. As noted by Daunfeldt (2001) this is a likely outcome if most of the observed zeros originate from the method of data collection and not from different processes determining the participation decision and the time allocation decision. There are, however, some exceptions to this result. For all years the own-marginal-wage-rate had a significant positive effect on the probability to observe positive labor supply on the market. The second significant effect was the presence of children, especially in low age brackets. These increased the probability of participation in the labor market for males and decreased it for females. This indicates that men provide the additional resources needed to bring up children, while childcare still seems to be women's work, although the negative effect of children on women's participation in the labor market was decreasing with time.

For women the own-marginal-wage-rate and education had also in almost all cases a significant negative impact on the probability of participation in preparing meals, cleaning and washing, while the presence of children, the number of household members and the housetype increased the probability in participating in these activities. As far as childcare is concerned, more years of education and the presence of young children had a significant impact on the probability to observe a positive time allocation to childcare activities for both men and women. However, the significance was stronger in the case of women. The presence of a childcare help was rarely significant and, counter intuitively, in some cases even positively significant. This may be due to the fact, that the effect of the presence of children was not isolated well enough in the model for childcare help to actually reduce the amount of time spent on childcare activities by the individual. The only two significant variables increasing the probability in taking part in maintenance and gardening for males were car ownership and housetype, having both a positive impact on these activities. This is not surprising, since these variables increase the potential amount of work to be performed.

The results from the second hurdle estimation are presented in tables 16 to 24 in the appendix. First, I want to discuss the wage and tax-effects on the time-use and in the next chapter I will

proceed to discuss the effects of the other socioeconomic variables. From tables 16, 23 and 24 if follows that male and female labor supply will increase due to an increase in the own net-wage, while it will decrease, when the spouse's wage rate increases. The corresponding elasticities evaluated at the mean values of the dependent and independent variables, are presented in tables 9 and 10. The highlighted, bold values indicate that the t-value of the estimated parameter was greater than 1.0 in absolute value[32]. First, only positive own-wage and negative or zero cross-wage elasticities can be observed, which confirms the predictions of the model. Second, a high variation of own- and cross-wage elasticities can be found for both sexes depending on the year of analysis. While the lowest own-wage elasticity is 0.05 for men in the years 1970 and 1980, the highest elasticity is 1.33 for women in the year 1970. The major differences in the own-wage elasticities between men and women are the own-wage elasticities being all significant and much higher for women, than for men, while cross-elasticities only yield significant results for women. Except for the year 1970 they are, however, very low and nearly negligible. Thus the labor supply of men and women seems to be unresponsive to changes in their spouse's wage rate. In general, these results confirm the already available estimates of labor supply for Norway from the study of Aaberge et al. (2000).

TABLE 9 OWN AND CROSS-WAGE ELASTICITIES OF LABOR MARKET SUPPLY

	1970		1980		1990		2000	
	Own-wage elasticities	Cross-elasticities	Own-wage elasticities	Cross-elasticities	Own-wage elasticities	Cross-elasticities	Own-wage elasticities	Cross-elasticities
Male	0,05	0,00	0,05	0,00	**0,35**	**0,00**	**0,43**	0,00
Female	**1,33**	**-0,27**	**0,60**	**-0,02**	**0,41**	-0,03	**0,72**	-0,30

Bold numbers indicate that t-values in absolute terms were greater than 1.0.

TABLE 10 POOLED OWN AND CROSS-WAGE ELASTICITIES OF LABOR MARKET SUPPLY

	Own-wage elasticities	Cross-elasticities
Male	**0,15**	0,00
Female	**0,69**	**-0,02**

Bold numbers indicate that t-values in absolute terms were greater than 1.0.

[32] This relatively low level of significance has been chosen, because often very few parameters yielded significant results on the usual 5% significance level, which stems from the high number of parameters to be estimated in each regression and the low number of observations in some of the estimations. The same problem has been envisaged in the study of Kapteyn and Kooreman (1987).

Further, I have calculated the elasticities with respect to the marginal tax-rate, since I am mainly interested in the effects of marginal tax rate changes. For labor market supply the corresponding elasticities have been calculated as $-\left(N'_w \overline{W}\ \bar{t}_m\right)/\overline{N}$, where $N'_w = \frac{\delta N}{\delta W_m}$. The effects on home production of a small change in the marginal tax-rate have been evaluated as $-\left(N'\ N'_w \overline{W}\ \bar{t}_m\right)/\overline{H}$, where $N' = \frac{\delta H}{\delta N}$. The corresponding elasticities are presented in tables 11 to 13.

TABLE 11 MALE OWN AND CROSS-WAGE ELASTICITIES WITH RESPECT TO THE MARGINAL TAX RATE

	1970		1980		1990		2000	
	Own-wage elasticities	Cross-elasticities	Own-wage elasticities	Cross-elasticities	Own-wage elasticities	Cross-elasticities	Own-wage elasticities	Cross-elasticities
Market work	-0,05	0,00	-0,05	0,00	**-0,26**	0,00	**-0,46**	0,00
Household Work	0,00	0,00	0,09	0,00	**0,07**	-0,01	**0,26**	0,00
Preparing Meals	0,02	0,00	0,20	-0,01	**0,86**	-0,01	**0,42**	0,00
Gardening	-1,21	0,02	-0,92	0,05	**-0,53**	0,01	**7,94**	0,01
Maintenance	0,17	0,00	0,03	0,00	**-0,04**	0,00	**0,10**	0,00
Childcare	-0,32	0,00	0,08	0,00	**-0,19**	0,00	**4,20**	0,01
Leisure	0,07	0,00	0,02	0,00	**0,13**	0,00	**0,04**	0,00

Bold numbers indicate that t-values in absolute terms were greater than 1.0.

TABLE 12 FEMALE OWN AND CROSS-WAGE ELASTICITIES WITH RESPECT TO THE MARGINAL TAX RATE

	1970		1980		1990		2000	
	Own-wage elasticities	Cross-elasticities	Own-wage elasticities	Cross-elasticities	Own-wage elasticities	Cross-elasticities	Own-wage elasticities	Cross-elasticities
Market work	**-0,58**	**0,11**	**-0,27**	**0,01**	**-0,19**	0,01	**-0,42**	0,15
Household Work	**0,03**	**0,00**	**0,00**	**0,00**	**0,00**	0,00	**0,12**	-0,04
Preparing Meals	**0,03**	**0,00**	**0,04**	**0,00**	**0,03**	-0,03	**0,03**	-0,01
Cleaning	**0,00**	**0,00**	**-0,02**	**0,00**	**-0,07**	0,00	**-0,17**	0,06
Washing	**0,05**	**-0,01**	**0,07**	**0,00**	**0,06**	0,00	**0,21**	-0,07
Childcare	**0,37**	**-0,07**	**0,50**	**-0,01**	**0,28**	-0,02	**1,60**	-0,54
Leisure	**0,07**	**-0,01**	**0,02**	**0,00**	**0,02**	0,00	**0,01**	0,00

Bold numbers indicate that t-values in absolute terms were greater than 1.0.

TABLE 13 POOLED OWN AND CROSS-WAGE ELASTICITIES WITH RESPECT TO THE MARGINAL TAX RATE

	Male		Female	
	Own-wage elasticities	**Cross-elasticities**	**Own-wage elasticities**	**Cross-elasticities**
Market work	**-0,13**	0,00	**-0,34**	0,01
Household Work	**0,09**	0,00	**0,14**	0,00
Preparing Meals	**0,36**	0,00	**0,44**	0,00
Cleaning			**0,00**	0,00
Washing			**0,10**	0,00
Gardening	**-0,09**	0,00		
Maintenance	**0,09**	0,00		
Childcare	**0,12**	0,00	**0,22**	-0,01
Leisure	**0,07**	0,00	**0,59**	0,00

Bold numbers indicate that t-values in absolute terms were greater than 1.0.

First it can be noted that most elasticities have the correct signs predicted by the theory. All males´ and females´ own-wage-elasticities with respect to market work are negative and all cross-elasticities are negative or zero. The results from the pooled estimation suggest that a one percent increase of the marginal tax-rate reduces males´ labor supply by about 0.1% and females´ labor supply by about 0.3%.

The effects on home production of a small change in the marginal tax-rate vary a lot depending on the year, sex and household activity. Most elasticities have the correct signs predicted by the model, except in the case of gardening in the years 1970 to 1990, maintenance in the 1990, childcare for men in the years 1970 and 1990 and cleaning for women in the years 1980 to 2000. In general only a few significant results can be found for men, while household budget restrictions seem to play a more significant role for women. All cross-elasticities expect in the case of women in the years 1970 and 1980 are found to be insignificant, and the few significant effects are very small. One interesting result observed is, that household budget restrictions are often more relevant, when considering the results from the single household activities, rather than household work per se. For females in the years 1970 to 1990 the household work own-wage elasticities are all between 0.00 and 0.03, while the elasticities for preparing meals vary around 0.04, for washing around 0.06 and for childcare between 0.28 and 0.50. The same observation can be made from the pooled estimation results, where the elasticities for preparing meals are four times higher, than the

corresponding elasticities related to the aggregate of household work. Thus, the same result could be found here as in the study by Daunfeldt (2001), who confirmed, that a highly aggregated time use category may mask considerable differences in budgetary influences on its disaggregated components.

Considering further the differences in elasticities with respect to the single household activities, the highest values in the pooled estimation results can be found in childcare and preparing meals. This may indicate that services provided by the market can be regarded as substitutes for these activities. In the case of maintenance, cleaning and washing, however, only very low elasticities are observed.

The results found so far confirm the specialization of function hypotheses described earlier in the text, as the household work of males, who are generally specialized in market work, is less responsive to wage rate changes than the household work of females, usually specialized in household work. The effect of a change of the marginal tax rate on leisure is found to be positive. Once again in the pooled estimation results the effect is much stronger for females than for males. A one percent increase of the marginal tax rate increases leisure by about 0.07% for males and 0.6% for females.

Summarizing the effects of the marginal tax rate, it can be said, that for both sexes an increase in the marginal tax rate results in a partial substitution of market work to household work and leisure, with the substitution effect being a lot stronger for females, than for males. It seems thus to be essential to include household production into a model, that has the aim of obtaining wage effects on labor supply. As long as wage effects are significant to changes in household production, its omission from a model could in general bias the estimated wage and income effects on labor supply and lead to wrong inferences.

Let us next consider the effects of nonlabor income on the different activities. The elasticities are presented in tables 14 and 15. In the case of non-leisure activities they mostly have the correct signs, i.e. an increase in nonlabor income decreases the amount of market work and household work done. Only in the case of childcare a higher nonlabor income seems to be associated with more time spent in this activity. Interestingly, the effect on leisure is ambiguous. For males in the years 1980 to 2000 the effect is positive, as predicted by the model. However in the year 1970 for males and in the years 1980 to 2000 an increase in nonlabor income decreases the total amount of leisure, although the responses of time use are negligibly small. This runs counter to the predictions of the model framework.

Table 14 Non-Labor Income Elasticities for Males and Females

	Male				Female			
	1970	**1980**	**1990**	**2000**	**1970**	**1980**	**1990**	**2000**
Market work	**-0,08**	-0,05	**-0,04**	-0,02	**-0,49**	0,00	**-0,17**	**0,08**
Household Work	**-0,08**	0,11	-0,02	-0,12	**-0,01**	**-0,01**	**-0,01**	**-0,07**
Preparing Meals	-0,08	-0,14	-0,20	0,00	**-0,02**	**-0,01**	-0,02	**-0,09**
Cleaning					-0,01	-0,01	-0,01	**-0,11**
Washing					**-0,07**	**-0,07**	**0,00**	0,25
Gardening	2,15	-0,44	-0,19	**-0,08**				
Maintenance	-1,07	-0,04	0,01	0,08				
Childcare	0,17	0,36	**0,12**	0,63	**0,18**	-0,01	**0,13**	**0,93**
Leisure	**-0,03**	**0,02**	**0,01**	0,00	**-0,02**	0,00	**-0,01**	-0,01

Bold numbers indicate that t-values in absolute terms were greater than 1.0.

Table 15 Pooled Non-Labor Income Elasticities

	MALE	FEMALE
Market work	**-0,03**	-0,02
Household Work	**-0,01**	**-0,01**
Preparing Meals	**-0,07**	**-0,01**
Cleaning		**-0,02**
Washing		-0,02
Gardening	-0,01	
Maintenance	-0,01	
Childcare	**0,04**	**0,12**
Leisure	**0,00**	0,00

Bold numbers indicate that t-values in absolute terms were greater than 1.0.

In the pooled analysis no significant effect can be found. Keeping in mind, that nonlabor income has been measured quite inaccurately within this study, these results can not necessarily prove to contradict the predictions of the Gronau model.

In general, when compared to studies discussed earlier in the text the effects of taxes and nonlabor income found within this study are well in agreement with the mainstream results.

5.2 Effects of other socioeconomic variables

Now let me consider some effects of the other socioeconomic variables, where I will only discuss the statistically significant results. With the exception of maintenance and gardening activities there is mostly a positive and significant effect of age on all work activities, although this effect is decreasing with age. On the other hand leisure time decreases with age, although only up to a certain point. This mirrors a life-cycle pattern of labor supply that first increases until a certain age and then starts to decrease. The same result has been found by Kapteyn and Kooreman (1987).

The variable centrality has mostly a positive effect on market work, which can reflect the fact of more job opportunities in bigger cities. The effect on preparing meals, washing, cleaning childcare and leisure is mostly negative, indicating that in general people substitute market work for household work activities and leisure in more populated areas, which is not surprising.

Education has a positive effect on male and female market work in the four separate studies, while it is not significant in the pooled results. On average an increase of education by one year implies a one hour increase of market work for males and about 1,5 hours more market work for females. On the other hand, it can be deduced from the pooled estimation results, that a one year increase in education decreases females household work by around 1,15 hours, while no significant effect can be found for males. Similarly, it increases females' leisure by 0.35 hours with no effect for males in the pooled analysis. Thus, in general, educational attainment seems to be more relevant for the allocation of time for females, than for males. Another interesting aspect is that for both sexes more years of education imply more time spent with children.

The number of household members has a strong positive effect on all household work activities for females, while the significant effects are negative for males' household work and females' leisure time. Since this variable also includes the number of children in the household, it simply states the fact that the increased amount of work due to more household members is done by females. Since males' market work is affected positively or negatively by the number of household members depending on the year of estimation, as can be seen in table 14, it is not clear from these results how males react with respect to this variable.

The effect of small children has a very strong effect on the allocation of time of both males and females. The effect is clearly strongest for females and their time spent on childcare. While the pooled estimation results suggest, that an additional child below the age of three

results in about 20 hours more time spent on childcare for females, males increase their time use in this activity by only 3 hours. Simultaneously females reduce their market work time by around 5 hours and their leisure time by 4 hours, so that the additional 11 hours per week must come from a reduction of other activities, e.g. sleeping time. However, with increasing age this effect decreases considerably, so that in some cases children in the age bracket 13-17 even reduce the time spent on childcare by females, probably because they look after themselves.

The variables childcare help and household help yield counter-intuitive results. The presence of childcare help seems to increase the amount of time spent in childcare activities and the presence of household help increases in the same way the amount of household work for females and decreases their leisure time. This may be due to the fact mentioned during the first-hurdle estimation or due to a poor measurement of these variables during the data collection. The knowledge of exact hours of childcare and household help provided would improve the estimation of the effects of these variables. However, this information was not given in the current data sets.

The next three variables, housetype, car and ownership of a leisure house all have similar effects. In general, they imply a higher allocation of time of males and females to household activities. In the pooled estimation results a strong positive effect of these variables on the amount of maintenance activities done by males can be seen.

The last variable is “year”, which indicates the changes in time allocation in the four different decades the data sets stem from. For females this variable is highly significant for all activities except washing. It has a positive effect on the amount of time allocated to market work, childcare and leisure and a negative effect on the aggregate of household work, preparing meals and cleaning. These results mirror the fact of growing female participation in the labor market, a reduction in their traditional role of performing household work and the growing amount of leisure. Regarding a general drop in the number of children per household in the last decades, the fact that time allocated to childcare increased though time might be surprising. A possible explanation is, that parents nowadays prescribe a higher value to the individual child, than 30 years ago, thus investing more time in them. The diminution of traditional work patterns is also visible from the effects of the year variable on males´ allocation of time. As a reflection of the results of females, males allocate today less time, than in the past to market work and more time to household production activities such as preparing meals and childcare. Interestingly, the effect on childcare is much stronger for

males than females, showing a smaller growing gap between the time of females and males spent on childcare activities.

6 Conclusions

The results of this paper suggest that changes in marginal tax rates on labor income not only have a significant influence on the supply of labor to the market, but also on the allocation of time to different household production activities. Thus policy makers and economists should include the effects to household production behavior in their deliberations of possible changes of the tax system.

The results also show that it is worthwhile to perform a disaggregated analysis of household work activities, since the single activities can yield quantitatively and qualitatively different results compared to an aggregate of household work, thus shading light on the varying importance of socioeconomic variables for the allocation of time. This seems to be particularly important for the analysis of a change of the marginal tax rate on different household activities, since its effects vary largely, depending on the particular activity. For future research an even higher degree of disaggregation could be desirable, since it could add more precise information on the allocation of time of single households.

In order to improve the estimates, more accurate information from the data sets on wage and income variables is important, so that the individual budget sets can be represented more precisely. This could reduce the variability of wage and income elasticity estimates, which stem from insufficient data availability.

Another result, which is the consequence of the rejection of the Tobit model in favor of the Cragg model, is, that allocation of time decisions are two step decisions, differentiating between the participation and the actual allocation of time decision. The allocation of time decisions of individuals present thus more complexity then allowed for by the Tobit model.

The last result of this paper is that it yields empirical support in favor of the Gronau model framework, which has been found to be empirically valid in this study. Thus, the inclusion of household work into an analysis of labor supply seems to give more accurate estimates of labor supply elasticities. However, extensions of the model framework are advisable in order to be better able to model intrahousehold allocation of time decisions. A prerequisite to this is nevertheless the availability of more detailed data sets on the time use of more then just one person per household.

7 APPENDIX

TABLE 16 ESTIMATION RESULTS FOR MARKET WORK

	Male				Female			
	1970	**1980**	**1990**	**2000**	**1970**	**1980**	**1990**	**2000**
Household Work Predicted	**-.2724457**	**-.6156564**	**-.1585774**	**-.1448794**	**-.5885362**	**-.9901167**	**-.0397471**	**-1.126536**
	-1.48	-1.10			-1.00	-2.06		-1.77
Nonlabor income	**-.0001073**	**-.0000471**	**-.0000282**	**-9.69e-06**	**-.0002336**	**-2.46e-06**	**-.0001469**	**.0000451**
	-2.21		-1.11		-2.23		-1.91	1.56
Marginal wage rate	**.0322215**	**.0254079**	**.1655681**	**.0775796**	**.2389624**	**.1063894**	**.1341776**	**.190363**
			3.60	2.34	6.21	3.52	4.30	5.08
Spouse's marginal wage rate	**-.0005309**	**-.0013651**	**-.0022529**	**.0002596**	**-.0463919**	**-.0040354**	**-.0084489**	**-.0074339**
			-1.30		-2.54	-1.77		
Age	**-.3580722**	**.687837**	**2.036526**	**3.561348**	**1.865956**	**.1648909**	**2.097574**	**3.202091**
		1.38	1.94	2.46	1.76		2.23	2.62
Age²	**.0051635**	**-.0072668**	**-.0230607**	**-.0425303**	**-.0222673**	**-.0040305**	**-.0275498**	**-.0406518**
		-1.15	-1.96	-2.65	-1.74		-2.47	-3.01
Centrality	**-.2556062**	**-2.007187**	**-.6961258**	**1.445011**	**2.621121**	**1.062291**	**.1340511**	**.427234**
		-2.15		1.39	1.91	0.95		
Years of Education	**.7312485**	**.8019906**	**.8168678**	**1.536109**	**1.467403**	**.6448013**	**2.09**	**1.284313**
	1.24	1.92	1.64	2.26	1.54	1.05	1.34	1.69
Household Members	**-2.93972**	**1.711219**	**-1.243893**	**4.229549**	**3.864276**	**1.049522**	**1.62**	**.5903474**
	-2.60	1.75	-1.42	2.46	2.47			
Children 0-2	**2.330159**	**1.615783**	**-4.250114**	**-1.599075**	**-16.9102**	**-2.901336**	**3.688042**	**-4.211365**
					-2.53			
Children 3-6	**2.000328**	**-2.55312**	**1.955005**	**.3345841**	**-5.572121**	**-4.86722**	**-5.850089**	**-5.704502**
					-1.22	-1.07	-1.65	-1.29
Children 7-12	**7.059776**	**1.96595**	**-4.24063**	**-2.269392**	**-4.374964**	**.0109559**	**.4413433**	**4.541754**
	2.65		-1.23		-1.02			1.16
Children 13-17	**3.555195**	**.2157218**	**-1.87562**	**-6.857502**	**-4.896881**	**5.965925**	**5.540792**	**.9849956**
	2.07			-1.76	-1.60	1.85	1.83	
Childcare help	**4.641268**	**-4.739484**	**-7.832881**	**-1.889476**	**6.004476**	**-1.43128**	**-6.029879**	**-5.619339**
	1.16	-1.48	-2.04		1.23		-1.83	-1.19
Household help	**-.2031715**	**1.185463**	**-4.565082**	**1.746869**	**.9780743**	**3.171322**	**-2.48478**	**.9155235**
							-0.65	
Housetype	**.2042966**	**-2.01427**	**-1.687546**	**-2.606302**	**4.214736**	**-.5337905**	**.5841785**	**-2.606933**
		-1.04			1.59			
Car	**3.129311**	**-1.474992**	**-4.138063**	**-2.606302**	**-.2149709**	**-4.443574**	**9.472055**	**6.017839**
	1.69		1.23			-1.09	3.21	1.46
Leisure House	**1.832257**	**.8033582**	**-3.159574**	**-2.087235**	**-2.818638**	**2.812837**	**.3310388**	**-1.617154**
			-1.36			1.08		
Constant	**40.12028**	**37.04413**	**25.22509**	**30.14015**	**33.82347**	**47.40599**	**22.27443**	**48.49306**
	3.63	4.11	2.27	2.43	1.32	2.82	1.59	2.40

T-values greater 1.0 in absolute terms are displayed below the bold parameters.

TABLE 17 ESTIMATION RESULTS FOR HOUSEHOLD WORK

	Male				Female			
	1970	**1980**	**1990**	**2000**	**1970**	**1980**	**1990**	**2000**
Market Work Predicted	**-.1662375**	**-.3848856**	**-.4887984**	**-.149141**	**-.1571167**	**-.1209868**	**-.0180287**	**-.177754**
	-2.24				-3.61	-4.94	-4.35	-4.93
Nonlabor income	**-.0000101**	**.000022**	**-2.87e-06**	**-.0000123**	**-.0000117**	**-.0000144**	**-9.13e-06**	**-.0000246**
	-1.30				-1.33	-1.51	-1.20	-2.58
Age	**.2333736**	**1.234984**	**-.705102**	**-.2787287**	**.9230527**	**.1616172**	**-.030075**	**.2736914**
	1.21				2.69			
Age²	-.0021004	**-.0156672**	**.0095092**	**.0045842**	**-.0094122**	**3.55e-06**	**.0029506**	**.0007893**
					-2.27			
Centrality	**-.2525128**	**4.479143**	**-1.381248**	**.582291**	**-.0459631**	**-.2993826**	**-.1774373**	**-1.149211**
		1.00		1.39				-2.85
Years of Education	**.065734**	**-2.046185**	**-.5109715**	**-1.114452**	**-.8413583**	**-.5190249**	**-.3220895**	**.2812106**
		-1.07		-4.80	-3.34	-3.00	-1.81	1.22
Household Members	**.0379238**	**-6.285252**	**.0231239**	**.3030188**	**-.1561337**	**.1706108**	**.7087616**	**-1.204417**
		-1.13		1.28			1.43	-1.71
Children 0-2	**.6774589**	**8.14248**	**-7.717923**	**-3.098541**	**.1989306**	**3.090126**	**-1.238641**	**1.321672**
			-1.21			2.19		
Children 3-6	**.2601466**	**-15.28516**	**-5.981785**	**-1.747666**	**-.6008153**	**-.9084168**	**-1.786383**	**-3.174298**
		-1.04	-1.03				-1.27	-1.83
Children 7-12	**1.014936**	**.2615989**	**2.596603**	**-.84326**	**.9427302**	**.5833677**	**-1.615572**	**-1.665483**
	1.18						-1.37	-1.15
Children 13-17	**-.4355383**	**-1.382039**	**-1.821048**	**4.806444**	**3.264055**	**-.152062**	**1.103375**	**1.705712**
				1.02	3.68			1.04
Childcare help	**.0308139**	**11.53813**	**-.4422326**	**-1.461435**	**-5.413765**	**-2.027232**	**-3.900065**	**-3.288407**
					-2.68	-1.50	-2.92	-1.86
Household help	**-.048494**	**7.611077**	**4.646549**	**5.023748**	**2.951809**	**-.2123637**	**-1.390714**	**.1176643**
					1.46			
Housetype	**.2093127**	**12.86524**	**2.222799**	**6.908566**	**.8596921**	**.0318256**	**-.0169034**	**1.023599**
		1.20		1.89	1.02			1.01
Car	**-.0616428**	**-14.35671**	**-1.094936**	**-2.176188**	**-.6644284**	**-.186466**	**-.0326917**	**-2.097726**
		-1.10						-1.35
Leisure House	**.026147**	**8.992211**	**1.154527**	**-.2358576**	**-.6973746**	**-1.277824**	**.9792579**	**.4965747**
						-1.44	1.11	
Constant	**8.671494**	**-18.21188**	**17.90709**	**17.25511**	**68.67651**	**43.03962**	**44.58272**	**66.4348**
	1.69				8.96	11.58	7.73	66.4348

T-values greater 1.0 in absolute terms are displayed below the bold parameters.

TABLE 18 ESTIMATION RESULTS FOR PREPARING MEALS

	Male				Female			
	1970	**1980**	**1990**	**2000**	**1970**	**1980**	**1990**	**2000**
Market Work Predicted	**-.0104048** -1.16	**-.238441** -2.58	**-.1566416** -1.80	**-.1127231** -1.10	**-.0409149** -4.74	**-.0766014** -3.45	**-.6499271** -2.86	**-.0162253** -4.83
Nonlabor income	**-.0000713**	**-9.99e-06**	**-7.86e-08**	**-2.41e-07**	**-7.61e-06** -2.03	**-6.72e-06** -1.49	**-4.01e-06**	**-.0000133** -2.71
Age	**3.217453**	**.1347902**	**.8921734** 2.33	**.3238035**	**.3588066** 2.40	**.0410835**	**-.2691127** -1.50	**.5295159** 2.33
Age²	**-.0306394**	**-.0013517**	**-.0099238** -2.36	**-.0033557**	**-.0033277** -1.85	**.000183**	**.0039584** 1.94	**-.0038514** -1.60
Centrality	**-3.370853**	**-.1473647**	**-.6279982** -1.54	**-.166012**	**-.3067865** -1.57	**-.1009833**	**.4008544** 1.81	**-.556783** -2.67
Years of Education	**-.1882368**	**-.2253271** -1.20	**-.2144711** -1.53	**-.3943588** -1.86	**-.1815865** -1.68	**-.2356955** -2.87	**-.1372501** -1.45	**.0536516**
Household Members	**-3.240739**	**-.6220843**	**.0312911**	**-.9443564** -1.32	**-.2662521** -1.10	**.2779228** 1.37	**-.1545616**	**-1.269016** -3.44
Children 0-2	**3.141961**	**1.523332**	**-1.231433**	**-1.582246**	**-.5784172**	**2.48865** 3.64	**1.501073** 1.76	**1.117748** 1.16
Children 3-6	**-7.528908**	**-1.799173** -1.25	**-.4800083**	**.380532**	**-1.408741** -2.63	**-1.517679** -2.47	**-.5808207**	**-.8528583**
Children 7-12	**-7.54428**	**-2.661268** -1.71	**2.555478** 2.04	**-.6389493**	**.0573723**	**-.8342081** -1.50	**-1.195488** -1.89	**-.5505657**
Children 13-17	**2.256511**	**.8952147**	**-.2972271**	**1.448283**	**1.145401** 3.03	**-.4542412**	**.9399136** 1.28	**1.34984** 1.58
Childcare help	**6.364728**	**.4979427**	**.4000436**	**2.549055** 1.43	**-1.898373** -2.21	**-.7157121** -1.09	**-1.463171** -2.03	**-1.740889** -1.89
Household help	**8.21548**	**-.5128182**	**.4000436**	**.8045658**	**1.177374** 1.37	**-2.097314** -2.14	**-.1062268**	**.6439441**
Housetype	**-.9508758**	**-.2330648**	**-.4364221**	**.1445086**	**.2232741**	**-.293539**	**.0296243**	**.6118132** 1.17
Car	**-8.634967** -1.03	**.8396416**	**1.44667** 1.20	**1.987059** 1.37	**-.5170974** -1.35	**.0969254**	**.3625884**	**1.160175** 1.47
Leisure House	**-.2596329**	**-1.33347** -1.22	**.5927922**	**-.2141212**	**-.8203768** -1.94	**-.1066095**	**.9951418** 2.13	**-.1068146**
Constant	**199.967** 1.22	**18.81225** 1.61	**5.126529**	**2.869557**	**28.68225** 8.58	**15.55564** 8.92	**14.92081** 4.88	**34.03054**

T-values greater 1.0 in absolute terms are displayed below the bold parameters.

TABLE 19 ESTIMATION RESULTS FOR CLEANING AND WASHING FOR FEMALES

	Cleaning				Washing			
	1970	**1980**	**1990**	**2000**	**1970**	**1980**	**1990**	**2000**
Market Work Predicted	**-.0004527**	**.03468**	**.0755744**	**.0397001**	**-.0273443**	**-.0517698**	**-.039959**	**-.080864**
			1.48	1.13			-2.28	
Nonlabor income	**-2.54e-06**	**4.32e-06**	**-1.97e-06**	**-6.38e-06**	**-.0000117**	**-.000011**	**-3.86e-07**	**.0000239**
				-1.61	-1.87	-1.65	-1.44	
Age	**.5097313**	**-.1468657**	**.2581359**	**.1391487**	**.4311096**	**.024729**	**.3743394**	**-.9284324**
	2.56				1.70		2.06	
Age²	**-.0054311**	**.0024118**	**-.0016291**	**-.0006868**	**-.0049685**	**.024729**	**-.0037717**	**.0102953**
	-2.26	1.09			-1.61		-1.82	
Centrality	**-.7161523**	**-.0473042**	**-.5898003**	**.0478012**	**.1511746**	**.1925964**	**-.3525095**	**-.5024577**
	-2.71	-4.44	-1.54				-1.66	
Years of Education	**-.2288954**	**8.907095**	**-.0644875**	**.0437791**	**-.1570925**	**-.1347823**	**-.1535024**	**-.2095334**
	-1.53	1.66					-1.74	
Household Members	**-.4151318**	**.9966421**	**.4153556**	**-.3171215**	**.2629511**	**.4504026**	**.2043202**	**.2906763**
	-1.30			-1.07		1.33		
Children 0-2	**.6078304**	**-1.405234**	**-1.597006**	**-.1614495**	**1.594557**	**1.432934**	**.4487722**	**.7605338**
		-1.15	-1.10		1.69	1.27		
Children 3-6	**1.051269**	**.8165966**	**-.4362698**	**-.4096826**	**-.2003039**	**1.374555**	**.0577504**	**5.273915**
	1.48					1.30		1.06
Children 7-12	**.4411959**	**-.4133416**	**.1185515**	**-.36806**	**.0059811**	**-.8418905**	**-1.627861**	**2.275253**
							-2.66	
Children 13-17	**1.414868**	**.8680464**	**-.2422737**	**-.2854825**	**.6953349**	**.7635172**	**.6013368**	**-.3056019**
	2.82				1.18			
Childcare help	**-1.41042**	**-.7336052**	**-1.836541**	**-2.203108**	**-.0050572**	**-1.413122**	**-1.304102**	**4.398041**
	-1.19		-1.49	-2.86		-1.21	-1.90	
Household help	**-1.866098**	**2.051272**	**-1.674343**	**-.1940907**	**2.855304**	**2.482771**	**-.4363268**	**-14.38994**
	-1.50	1.25			2.27	1.86		-1.40
Housetype	**.017549**	**-.430643**	**.4838497**	**-.0352775**	**.3678874**	**-.5607843**	**-.267619**	**2.233723**
Car	**-.8331391**	**-.2965393**	**-.3232026**	**-.4403575**	**-1.288072**	**-1.221525**	**-.1423833**	**.8626012**
	-1.63				-2.07	-1.24		
Leisure House	**.8643676**	**.975633**	**-.9290028**	**.5313974**	**-.155166**	**.768593**	**-.2525981**	**.7822998**
	1.56	1.20	-1.12	1.32		1.07		
Constant	**20.31711**	**11.61451**	**14.05535**	**12.71586**	**8.383772**	**3.422572**	**9.772059**	**-7.116578**
	4.54	3.55	2.66	3.31	1.50	1.13	3.15	

T-values greater 1.0 in absolute terms are displayed below the bold parameters.

TABLE 20 ESTIMATION RESULTS FOR GARDENING AND MAINTENANCE FOR MALES

	Gardening				Maintenance			
	1970	**1980**	**1990**	**2000**	**1970**	**1980**	**1990**	**2000**
Market Work Predicted	**.8870524**	**.814769**	**.0471082**	**-1.253013**	**-.1343204** -2.13	**-.0602896** -1.05	**.0102719**	**-.0217958**
Nonlabor income	**.0001058**	**-.0000216**	**-3.63e-06**	**-.00000201** -1.13	**-.0000578**	**-3.06e-06**	**1.72e-07**	**-2.17e-06**
Age	**-1.073227**	**-.6715103**	**-1.085304** -1.56	**8.158665**	**.2340672** 1.43	**-.1844028** -1.37	**.1639897**	**-.0846601**
Age²	**.0112964**	**.0088255**	**.0125187** 1.65	**-.0602976**	**-.0029855** -1.56	**.0016589** 1.05	**-.0020641**	**.0005263**
Centrality	**8.209058**	**-2.114097**	**-.4616631**	**-6.882176**	**.1627402**	**.277521** 1.15	**.1640379**	**.3169957**
Years of Education	**4.04378**	**.5706152**	**-.1178356**	**.8783924**	**-.0444409**	**.1067662** 1.10	**-.0827047**	**.0222838**
Household Members	**-1.739851**	**2.558306**	**.4909488**	**-21.13233** -1.11	**.3205561** 1.12	**.0609188**	**-.049233**	**-.3276533**
Children 0-2	**-4.885723**	**-19.95065** -1.23	**2.583011**	**13.29154**	**.1869189**	**-1.206329** -1.38	**-.8116322**	**-1.57044** -1.38
Children 3-6	**-20.75223**	**-13.60728** -1.09	**-7.152017** -1.76	**8.196322**	**.3584026**	**-.3097648**	**-1.292079** -1.23	**.4069519**
Children 7-12	**-29.26405**	**-11.49822** -1.10	**-4.853202** -1.41	**-4.13593**	**-.8851342** -1.22	**-.098443**	**-1.6547** -1.85	**.3156911**
Children 13-17	**1.624441**	**8.52866**	**-.2121353**	**50.17869** 1.12	**-.0461293**	**.5081065**	**-.4687561**	**-.1473775**
Childcare help	**44.57979**	**4.183343**	**4.109924** 1.08	**-18.89246**	**-.1854034**	**-.3082839**	**1.501111** 1.59	**-1.076104** -1.09
Household help	**-63.55938**	**-51.25162**	**-2.526368**	**31.93299**	**-1.002306**	**-1.175759**	**1.442484**	**1.406154**
Housetype	**-5.589581**	**10.00932** 1.24	**-.0616012**	**18.27283**	**.5493506** 1.21	**.0038664**	**1.036676** 1.62	**.5161239**
Car	**-.0974771**	**-7.090157**	**-4.295884** -1.57	**8.347114**	**.7763502** 1.60	**.1748182**	**1.589265** 1.83	**5161239** 1.36
Leisure House	**-.21383**	**1.490891**	**.6715492**	**1.82895**	**.0753806**	**.4704087**	**.6065086** 1.01	**.1135846**
Constant	**-151.681**	**-39.69991**	**12.06186**	**551.5199** 1.14	**3.358388**	**8.526916**	**1.698916**	**6.538848**

T-values greater 1.0 in absolute terms are displayed below the bold parameters.

TABLE 21 ESTIMATION RESULTS FOR CHILDCARE

	Male				Female			
	1970	**1980**	**1990**	**2000**	**1970**	**1980**	**1990**	**2000**
Market Work Predicted	**.100597**	**-.0603439**	**.0286197**	**-.686955**	**-.2434841**	**-.4174587**	**-.2762397**	**-.4631658**
				-2.23	-1.81	-3.08	-1.67	-1.79
Nonlabor income	**.0000164**	**.0000227**	**4.86e-06**	**.0000299**	**.0000328**	**-1.66e-06**	**.0000215**	**.0000664**
			1.17		2.52		1.16	2.52
Age	**1.068574**	**-.7732082**	**4.004545**	**4.262985**	**1.695169**	**-.3008436**	**-1.324613**	**2.613311**
	1.31		2.06	1.98	2.03		-1.06	1.51
Age²	**-.0119942**	**.0123362**	**-.0468035**	**-.058907**	**-.0265759**	**.0042257**	**.0145136**	**-.0451759**
	-1.15	1.20	-1.98	-2.08	-2.23			-1.92
Centrality	**-1.230702**	**.2883693**	**1.449196**	**-.3716278**	**-.1652195**	**-1.721372**	**1.173959**	**1.518095**
	-1.06					-1.77	1.00	1.27
Years of Education	**.4335872**	**1.440432**	**-.2131962**	**.3512356**	**.57736**	**-.06623**	**.6166315**	**.5177021**
		2.02			1.39		1.23	
Household Members	**.0931065**	**-4.497932**	**-2.299478**	**5.823202**	**2.376482**	**.7142638**	**4.515792**	**9.071513**
		-1.67		2.14	1.90		2.17	3.00
Children 0-2	**2.839757**	**8.379779**	**9.43467**	**7.571707**	**14.17544**	**22.36726**	**17.49998**	**12.44032**
	1.07	1.84	2.12	2.04	6.67	6.21	4.88	2.95
Children 3-6	**-.6044247**	**2.626525**	**-6.17023**	**2.049096**	**4.668133**	**5.917712**	**7.542912**	**.183809**
			-1.46		2.42	2.35	2.45	
Children 7-12	**-.5876068**	**1.45723**	**-1.13019**	**.3024925**	**-6.617226**	**3.594727**	**2.92166**	**-3.021882**
					-2.64	1.27		
Children 13-17	**-4.865474**	**-.2979743**	**-11.82735**	**-10.24654**	**-6.610162**	**-9.493588**	**-10.31038**	**-22.47606**
	-1.45		-1.94	-2.14	-3.42	-2.78	-2.55	-3.47
Childcare help	**-3.295494**	**-1.624536**	**2.379594**	**1.636821**	**4.793801**	**1.997537**	**5.641638**	**2.798649**
					1.32		1.78	
Household help	**-.7467035**	**-5.136587**	**3.252463**	**3.256879**	**-2.870225**	**1.704899**	**7.765664**	**-14.05934**
							1.44	-2.05
Housetype	**1.129943**	**-2.430149**	**-1.130154**	**1.495715**	**-.3642717**	**-2.051732**	**-.9712002**	**-1.505926**
						-1.01		
Car	**1.172808**	**.686472**	**9.537912**	**.4674182**	**-1.358165**	**-4.534095**	**.516895**	**2.18506**
			1.59			-1.30		
Leisure House	**-2.614561**	**-3.838229**	**1.073148**	**-2.482547**	**2.269307**	**-1.084644**	**3.307617**	**.1108893**
	-1.08	-1.02			1.34		1.39	
Constant	**28.23546**	**47.96347**	**39.19373**	**-115.4689**	**-43.70537**	**3.279457**	**-69.9436**	**-115.8493**
		1.06		-1.69	-1.99		-2.50	-2.69

T-values greater 1.0 in absolute terms are displayed below the bold parameters.

TABLE 22 ESTIMATION RESULTS FOR LEISURE

	Male				Female			
	1970	**1980**	**1990**	**2000**	**1970**	**1980**	**1990**	**2000**
Market Work Predicted	**-1.003321** -4.26	**-.3759091** -2.38	**-.4642256** -2.48	**-.176661**	**-.3174481** -3.53	**-.1546217**	**-.1629181** -2.01	**-.0551831**
Nonlabor income	-.0000295 -1.24	**.0000313** 1.40	**-6.89e-06** -1.06	2.32e-06	**-.0000198** -1.57	**-2.59e-06**	**-.0000116** -1.10	**-9.55e-06**
Age	**.5094509**	**-.380028** -1.01	**-1.4443** -1.96	**-1.725854** -2.13	**-1.364559** -2.67	**-.2224641**	**-1.067929** -2.38	**-1.289619** 2.12
Age²	**-.007707** -1.04	**.004132** 0.94	**.0167937** 2.05	**.0234031** 2.75	**.0152708** 2.47	**.0023721**	**.0130377** 2.58	**.0158314** 2.40
Centrality	**-.6733406**	**-.0067925**	**-.2450418**	**-.4128345**	**.2790035**	**.2177164**	**-1.653245** -3.04	**-.1546854**
Years of Education	**-.676992** -1.50	**-.4820723** -1.66	**.2545958**	**.1032492**	**.866955** 2.32	**-.219788** -1.07	**-.2375866** -1.00	**.125448**
Household Members	**2.024913** 1.70	**-1.092097** -1.27	**-.3458498**	**-3.669927** -3.22	**-1.861951** -2.19	**-.6398466** -1.23	**-.9550385** -1.45	**-2.025202** -1.96
Children 0-2	**-4.654533** -1.57	**3.72628** -1.47	**1.801391**	**1.54646**	**-1.561934**	**-4.514486** -2.71	**-.4883486**	**-3.259206** -1.18
Children 3-6	**-2.570086**	**.6800829**	**-.3585471**	**-2.943265**	**-.1650786**	**-.368614**	**-4.359828**	**-4.368698** -1.70
Children 7-12	**-6.488572** -2.32	**-5.322902** -2.38	**3.043059** 1.15	**1.567988**	**.4717719**	**-.9732319**	**-2.254624** -1.41	**-1.330803**
Children 13-17	**-4.547802** -2.54	**-2.113472**	**3.120636** 1.09	**7.923464** 2.88	**.1844602**	**.489115**	**-.7548668**	**5.975902** 2.51
Childcare help	**-4.286906**	**4.450547** 1.80	**-2.521516**	**-6.536782** -2.10	**-3.079394** -1.01	**-1.701108** -1.07	**.263901**	**-.4020508**
Household help	**.5771903**	**5.055949** 1.39	**2.948376**	**.5938927**	**-3.81433** -1.22	**-2.755598** -1.17	**.6887517**	**4.916673** 1.41
Housetype	**-2.664159** -1.49	**-.6005007**	**-.4992086**	**-5.229198** -2.87	**-.8552573**	**-.4498793**	**2.933128** 2.44	**1.494736** 1.01
Car	**2.215988** 1.16	**.3626516**	**.3577642**	**.9428068**	**1.746102** 1.27	**1.523729**	**-3.688474** -2.29	**.9385629**
Leisure House	**-1.388388**	**-2.916918**	**.9450352**	**-.1759673**	**-1.189786**	**.5657881**	**-1.147393**	**-.4886233**
Constant	**40.13465** 1.39	**61.06041** 3.20	**75.70334** 3.30	**178.1358** 5.77	**21.06344** 1.87	**46.68602** 10.66	**64.70889** 8.71	**78.05227** 5.88

T-values greater 1.0 in absolute terms are displayed below the bold parameters.

TABLE 23 POOLED DATA ESTIMATION RESULTS FOR FEMALES

	Market Work	Household Work	Preparing Meals	Cleaning	Washing	Childcare	Leisure
Household Work Predicted	**-.141887**						
Market Work Predicted		**-.128355**	**-.047471**	**.0000658**	**-.0547968**	**-.3632615**	**-.1988034**
		-3.89	-3.23		-1.82	-4.36	-4.92
Nonlabor income	**-.0000106**	**-.0000113**	**-3.71e-06**	**-3.81e-06**	**-2.54e-08**	**.0000162**	**-1.10e-06**
		-2.44	-1.80	-1.16		2.36	
Marginal wage rate	**.1616994**						
	10.92						
Spouse's marginal wage rate	**-.0040426**						
Age	**1.295015**	**.2150831**	**.1193999**	**-.0283419**	**.1444236**	**-.0866889**	**-.651775**
	3.14	1.35	1.67				-3.50
Age²	**-.0180724**	**-.0006241**	**-.0005221**	**.0009724**	**-.0013109**	**-.0005068**	**.0076553**
	-3.71						3.52
Centrality	**.1600818**	**.4789196**	**.222109**	**-.3690696**	**.0854212**	**-.7625938**	**-.3518427**
		2.20	2.31	-2.32		-1.60	-1.38
Years of Education	**.1422445**	**-1.151275**	**-.4091723**	**-.5212128**	**-.2744749**	**.857236**	**.3559557**
		-10.49	-8.29	-6.35	-2.79	3.71	2.84
Household Members	**-.5372332**	**1.116589**	**.2940619**	**.468484**	**.630514**	**1.653224**	**-1.06985**
		4.08	2.41	2.46	2.62	2.47	-3.29
Children 0-2	**-4.726489**	**-.4325028**	**.9214041**	**.7959161**	**.7344166**	**19.65584**	**-3.64628**
	-1.98		2.31	1.28		10.82	-3.43
Children 3-6	**-.7011328**	**1.815901**	**-.0058514**	**1.410284**	**-.3613066**	**3.838982**	**-2.634823**
		2.26		2.52		3.01	-2.73
Children 7-12	**-1.12006**	**1.656807**	**.235279**	**.5900431**	**-.4935036**	**-2.587464**	**-1.318056**
		2.24		1.12		-1.71	-1.48
Children 13-17	**.8862116**	**1.844436**	**.5231651**	**.6802746**	**.3700085**	**-8.368698**	**-.1587902**
		3.09	2.00	1.66		-4.89	
Childcare help	**-1.666673**	**-4.402436**	**-1.313308**	**-1.63193**	**-1.034483**	**1.603896**	**-.2785638**
		-5.30	-3.54	-2.68	-1.43	1.20	
Household help	**-.4804066**	**1.258132**	**-.0737297**	**-.4318839**	**1.699365**	**-.5866219**	**-1.548163**
		1.05			1.74		-1.10
Housetype	**-.218143**	**1.278796**	**.4399318**	**-.513488**	**-.2360898**	**-.9124656**	**1.822341**
		2.50	1.94	-1.41			3.00
Car	**2.10774**	**-2.95935**	**-1.065918**	**-1.151089**	**-1.669492**	**-1.225178**	**2.221214**
	1.26				-3.00		2.81
Leisure House	**.1663793**	**-.0539545**	**.0723698**	**-.0945663**	**-.1795444**	**.6939863**	**-.3758628**
Year	**1.0888671**	**-5.034241**	**-1.465135**	**-2.828521**	**.2286776**	**1.092566**	**3.571185**
	1.14	-18.62	-11.83	-12.21		1.79	10.90
Constant	**6.515337**	**29.50404**	**9.75776**	**.2624944**	**4.614793**		
		8.35	6.12		1.42		

T-values greater 1.0 in absolute terms are displayed below the bold parameters.

TABLE 24 POOLED DATA ESTIMATION RESULTS FOR MALES

	Market Work	Household Work	Preparing Meals	Gardening	Maintenance	Childcare	Leisure
Household Work Predicted	**.1135957**						
Market Work Predicted		**-.1050598** -4.03	**-.1465955** -2.49	**.0274394** 1.92	**-.0463513** -1.80	**-.0325512** -3.20	**-.5570073** 7.98
Nonlabor income	**-.0000225** -2.98	**-1.17e-06** -1.03	**-3.29e-06** -1.15	**4.96e-07**	**-7.13e-07**	**1.24e-06** 2.82	**-3.77e-06** -1.25
Marginal wage rate	**.0700869** 3.95						
Spouse's marginal wage rate	**-.0008354**						
Age	**.8925339** 2.55	**-.0500084**	**.3758141** 1.75	**-.085552** -1.85	**-.0716072**	**.1025798** 3.11	**-.5934736** -2.62
Age²	**-.0118959** -2.90	**.0007285**	**-.0038373** -1.61	**.0014306** 2.70	**.0004306**	**-.0012596** -3.33	**.0066974** 2.58
Centrality	**.9268033** 1.97	**-.0555906**	**-.3313563** -1.19	**.0077678**	**.2517954** 2.12	**-.0635661** -1.36	**.0163611**
Years of Education	**.2139441**	**.0075909**	**-.3782258** -3.07	**-.0429175** -1.58	**.0222248**	**.0832459** 4.31	**-.061876**
Household Members	**-.9528753**	**-.2228676** -1.51	**-.4958793** -1.33	**-.0206194**	**.0806026**	**-.0114975**	**-.3762647**
Children 0-2	**2.132525** 1.23	**-.2637903**	**-.0538586**	**-.0227526**	**-.8880713** -1.96	**2.764317** 15.49	**-2.466415** -2.01
Children 3-6	**.0396034**	**-.6793012** -1.61	**-1.461279** -1.35	**-.1113649**	**-.1961857**	**1.037745** 6.32	**-1.40706** -1.25
Children 7-12	**.2616809**	**.3940129**	**-.8136433**	**-.1376118**	**-.4689243** -1.17	**.404603** 2.57	**-1.852065** -1.72
Children 13-17	**.2409506**	**-.3713675** -1.19	**.0012341**	**.3018147** 1.77	**-.070927**	**-.3934462** -3.24	**-1.103483** -1.32
Childcare help	**-2.187343** -1.28	**.9629952** 2.19	**2.612812** 2.45	**.2695593** 1.12	**.0848109**	**1.30448** 7.61	**.1774725**
Household help	**.3666581**	**.6659042**	**.1501038**	**-.8089546** -2.10	**-.1926726**	**-.0244771** -0.09	**1.844617**
Housetype	**-1.416223** -1.32	**.7500906** 2.73	**-.1240104**	**.2558654** 1.70	**.6104021** 2.24	**.0188567**	**-.7554147** -1.03
Car	**-0.467023** -2.50	**-.0728973**	**1.06852** 1.27	**-.154124**	**.5041253** 1.44	**.2312735** 1.68	**2.261284** 2.40
Leisure House	**-.7040257**	**.2333731**	**-.2209077**	**.0820396**	**.268304** 1.23	**.1311729** 1.16	**-.4123257**
Year	**-3.26909** -4.18	**4.33896**	**1.077056** 2.97	**-1.529271**	**.068253**	**4.686644** 3.56	**2.516743** 5.57
Constant	**41.54565** 5.39	**13.58953** 6.27	**4.550938**	**1.856104** 1.57	**5.624526** 2.62	**-1.050455** -1.24	**83.2081** 14.34

T-values greater 1.0 in absolute terms are displayed below the bold parameters.

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