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the End of the Male Chauvenist Model**

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Household Production and Time Allocation, the End of the Male Chauvenist Model

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Abstract

In this paper we formulate a household production model to explain the allocation of time of women and men between paid labor, household work, care for children, care for the partner, and leisure time. Time allocation models provide a framework in which the value of household production can be estimated and the division of non-market time into different uses like child-rearing, housework, etc. can be analyzed. In this respect time allocation models are to be valued. The data for the empirical analyses are taken from the Dutch sample `Women on Work' 1991/1992 and the Dutch GPD survey 1991. Another question we will address concerns the effect of the `quality' of children on the allocation of time. The concept of `child quality' -as devised by Becker (1960) - enters the household production model to account for those characteristics of children, apart from their number, which provide utility to their parents.

The value of household production and the value of child care provided is calculated by means of the `opportunity costs approach'. The value of non market production is determined by the market wage rate. The calculated value says something about the value of alternative time use (time spent on non-market activities instead of market activities).

The empirical results show that the time allocation of the wife and the time allocation of her husband/partner are complements rather than substitutes; if she spends more time on an activity, he spends more time on this activity as well. And if he spends more time on it, she spends more on it as well. If the woman participates in the labor market, men do not take over much of the housework or care for children; he rather spends more time in the labor market as well. Children have a very large effect on the time allocation of women. Children hardly effect the time allocation of men. We found no results to confirm that the `male chauvinist model'; husband/partner decides, woman adjusts, still holds. Other income in the household has an insignificant effect. In determing their own labor supply females do not take theirs husband earnings into consideration. They do respond to changes in their own wage rates, to the presence and age of children and to the existence of marital conflicts. The estimates of the demand for `child quality' equations show that older women have fewer problems with their children. It is remarkable, however, that 80% of the women report having a child with sleeping problems. Women who are in the labor market have more obedient children. Years of education increase problems with children demanding attention and sleeping poorly. The total value of household production and child care in the household is substantial.

1 Introduction

The time allocation model developed in this paper can be seen as an extension of the Heckman (1974) labor supply model, and as a structural approach (with more activities ditinguished) to the household production model proposed by Gronau (1980). We formulate a household production model including four activities: market work, housework, child care and leisure.

The actual time use need not be ideal. It may be possible to prefer a time schedule different from the actual allocation of time. An individual might not be able to find a job consistent with actual preferences as regards number of working hours. This is the case with involuntary unemployment (where the actual number of working hours is zero) or with full-time employment if it is impossible for organizational reasons for the individual to work part-time. Equally, the actual allocation of time to housework or the care of children might not match individual preferences (for example, where the wife would prefer her husband to make a greater contribution to family care). Finally, there could be discrepancies between the time actually spent caring for children and the time the individual would like to spend on this activity. Paid employment reduces the time actually spent on child care. If no suitable non-parental child care is available, or if paternal child care would be preferred, actual and preferred time use need not necessarily correspond.

The time allocation model is both estimated on the basis of the actual distribution of hours between the activities distinguished and the preferred allocation of time. From both estimates we can calculate the value of household and market production. By comparing the value of production based on the actual allocation of time with the value of production based on the preferred allocation of time, it is possible to estimate the welfare gains from a more satisfactory (or optimal) allocation of time.

An important issue in household production models is returns to scale. Returns to scale in household production may explain the division of paid and unpaid labor between women and men (see Blau & Ferber 1992 for illustrations). Two types of economies of scale in household production can be distinguished. The first are returns to scale in household size. If there are positive returns to household scale, the value of household production is an increasing function of household size. Secondly, there may be returns to scale in the time spend on household activities. With constant returns to scale, each hour of household production yields the same value. With increasing (decreasing) returns to scale, the value of household production increases

(decreases) with the time spent on household activities. If there are increasing (decreasing) returns to scale, the average costs of household production decrease (increase) with the time spent on household activities. If the household production function exhibits first increasing and later on decreasing returns to scale, the average costs curve will be U-shaped. In that case, cost minimalization behavior means that the optimal scale of household production is at the point at which there are constant returns to scale.

Another question we will address in this paper concerns the effect of the quality of children on the allocation of time. The concept of `child quality' - as devised by Becker (1960) - enters the household production model to account for those characteristics of children, apart from their number, which provide utility to their parents. Willis (1971, 1973) presents a household production model in which household utility is determined by the number and quality of children. From this model it is possible to derive the demand for children equation and the demand for child quality equation. Due to lack of data, only the former equation is estimated in most of the empirical applications of this household production model. In this chapter we estimate demand equations for child quality. The child quality variables are also included in the time allocation model and used to explain time spent by the mother on caring for her children.

The outline of this paper is as follows. Section 2 offers a brief description of the data used in the empirical analysis of labor supply and time allocation. Section 3 contains some descriptive statistics on the actual and preferred time allocations of women and men. Section 4 gives a brief survey of the literature on empirical models of time allocation based on household production models. Section 5 presents the estimation results for the demand for child quality equations and Section 6 the household production model of paid labor, household labor, and maternal child care. Details of the econometric analysis can be found in Appendix A. Section 7 contains the estimation results of the time allocation model. Section 8 briefly summarizes the results of a replication of the time allocation model on another data-set. Section 9 presents some estimations of the value of household production and some simulations on the allocation of time for different types of households and Section 10 concludes the paper.

2 The data used from the `Women on work'[1] stratified sample.

The data for the estimations are taken from the stratified sample `Women on Work'. This sample contains information on time allocation, wages and individual characteristics from a written and a telephone survey. The data-set has the further advantage that it contains information on the quality of children. It also provides information on the women's actual and preferred time allocations.

For the estimation of the household production model we used information from the written survey only. From the stratified sample we selected women who had a job, were married/cohabiting and had children.

Measurement problems are an important factor in time use studies (Juster & Stafford 1991). Essentially, there are two methods of collecting time budget data: the time diary method and the recall method. Time diary data are usually considered to be more accurate (Juster & Stafford 1991; Gronau 1986, p.279; Flood & Klevmarken, 1992), but are more expensive to collect. In our data, time use was measured by asking the women to allocate actual and preferred hours per week for herself and her partner to the following activities: market work, voluntary work, household work, caring for children, personal care and leisure. For the analyses we used three categories of time use: market work, household work and caring for children. To comply with the adding-up constraint in econometrics, we omitted one category; leisure.

We also used information on characteristics of the child(ren) present in the household (boisterious, obedient, demands attention, sleeping problems, illness).

3 Time use patterns of women and men

Despite the fact, that - on average - more than 80 percent of women's time is devoted to non-market activities, little is known about how women allocate this time not devoted to paid labor. A cross-country comparison of time allocation in Juster & Stafford (1991) shows that on average women spend between 24 and 35 hours per week on market work, between 27 and 34 hours on

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[1] Maassen van den Brink, H (1994), Female labor supply, child care and marital conflict, Amsterdam University Press, Amsterdam, Chapter 2.

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housework, about 70 hours on personal care (including sleeping), and between 25 and 42 hours on leisure. Women in paid employment spend less time on housework and child care than women who are not employed.

The amount of time women spend on market work has increased over recent decades. At the same time, the amount of time spent on housework and child care has decreased. The time men spend on housework is roughly the same in all countries, the only exceptions being Norway, Sweden and Japan. Norwegian and Swedish men spend relatively more time doing housework, whereas Japanese men do not spend any time at all on caring for their children or doing housework. The international differences in housework time are much smaller for women than for men (Juster & Stafford 1991; SCP 1992).

On the basis of these international time use studies, we could conclude that the fact that the time men spend on housework and caring for children seems to be independent of female participation means essentially (in terms of overall time use) that the `male chauvinist model' dominates: male time expenditure is fixed while females `choose' between care, market work, market care, etc.. However, as the results in this paper will show, this conclusion would be somewhat premature. The relations between male and female labor supplies are more complicated. We will return to this issue later.

This section compares the actual and preferred time use of women and men in different household types. Five different household types are distinguished by labor force or non-labor force participation of the wife:

1. Dual-earner couples with no children (have paid employment/no children);

2. Families with children and where the wife has no paid employment, the husband/partner has paid employment, and there is no use of non-parental child care (no paid employment/children/no child care);

3. Families with children in which both spouses have paid employment and do not use non-parental child care (paid employment/children/no child care);

4. Families with children where the wife has no paid employment, the husband/partner has paid employment and there is use of non-parental child care (no paid employment/children/use of child care);

5. Families with children where both spouses have paid employment and use non-parental child care (paid employment/children/use of child care).

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Time use is divided into three categories: paid employment, housework and caring for children. Leisure and voluntary work are not considered. For each of the categories, actual and preferred time use is given.

Table 1 shows the average actual and preferred time use for market work, housework and child care for women in five types of households.

Table 1

Female average actual and preferred time allocation (hours per week) N=627

	market work		housework		child care	
	actual	preferred	actual	preferred	actual	preferred
market work, no children	34.3	31.6	25.9	26.1	0	0
no market work, children, no child care	0	10.4	41.6	36.2	26.6	25.2
market work, children, no child care	20.7	22.5	34.1	31.6	18.6	21.7
no market work, children, child care	0	11.7	38.4	30.1	34.8	31.3
market work, children, child care	19.5	21.3	29.7	25.5	28.0	29.0

In general, all women with children would prefer to have more market work and less housework. Women in full-time employment would like to reduce their working hours and would prefer to spend one more hour on housework. Women participating in the labor market would prefer to spend more time with their children and women not in the labor force would prefer to spend less time on child care, probably because they would prefer a job for about 10 hours per week. Gaps between actual and preferred time spent on non-market work, i.e. housework and child care, are large. On average, most gaps between actual and preferred time use on market work are small. However, the most striking result concerns the gap between actual and preferred allocation of market time for non-participating women, they would prefer a small part-time job (11 to 12 hours spend on market work).

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Table 2 presents the actual and preferred time use of men, as reported in the questionnaire by their female partners. In fact these results represent *her preferences on his time allocation.*

Table 2
Male average actual and preferred time allocation, as reported by spouses (hours per week)

	market work		housework		child care	
	actual	preferred	actual	preferred	actual	prefer-red
market work, no children	39.8	39.0	16.4	16.6	0	0
no market work, children, no child care	45.0	41.2	9.6	15.2	9.4	14.7
market work, children, no child care	43.4	38.3	13.6	18.4	9.6	16.1
no market work, children, child care	45.6	37.0	9.8	16.5	10.1	18.9
market work, children, child care	46.0	40.8	11.5	15.9	12.8	21.2

On average, men spend 10 to 16 hours per week on housework. Dual-earner families with no children present are those where the husband/partner spends most time doing housework. Families where women do not participate in the labor market are those where the husband/partner spends the least time on doing housework. Where women do have paid employment the husband/partner spends slightly more time on housework, but on average the differences are negligible between families where the woman has paid employment and those where she does not. Where the woman has paid employment, the husband/partner spends on average an extra one-and-a-half to four hours on housework.

Despite the fact that men spend so little time on housework, they do not spend much time with their children either. On average, they spend between 9 and 13 hours per week caring for their children. In families using non-parental child care, men spend somewhat more time with their children as compared to men in families who do not use non-parental child care. There are some, but only very minor, differences between traditional families and dual-earner families.

Women would like their husbands/partners to spend substantially more time with their children. On average, women would prefer paternal child care for 15 to 21 hours per week. This means an increase of five to ten hours per week. Labor force participants in particular would like their husbands to provide more family/child care. Women in paid employment and using non-parental child care would like their husbands/partners to spend more than twice as much time caring for the children as they actually do.

In general, we could speak of an `equality' in the time use of the partners in dual-earner couples without children (at least, if we define `equality' in this context as meaning an equal division in the time spent on paid and unpaid labor by women and men). The `inequality' between the two sexes' time use seems to be caused by the presence of children in the household.

It is obvious that women are rationed in their optimal allocation of time and that hours are institutionally fixed. The same is true of the way men allocate their non-market time, at least if we accept wives'preferences on his allocation of time. For the preferred allocation we may assume that hours of work can be varied freely. To see if there are any differences we present estimates based on the actual distribution of time as well.[2]

4 Survey of literature on household production models

In the empirical literature on the allocation of time within a household production framework two approaches can be distinguished. The first approach specifies a specific functional form for the household production function for the derivation of allocation equations. Examples of this approach are Graham & Green (1984) and Kooreman & Kapteyn (1987). Graham & Green (1984)

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[2] The criticism to the use of individual and household preferences in empirical research is mistaken. Individual and household preferences and behavior, indeed, depend on the relation between family members, social and cultural norms with respect to gender roles in society (which will vary over time). But, subjects are often, for instance, asked to respond to (hypothetical) questions such as: Would you still use your car if the level of road tax doubled? In every day life we take almost 99 per cent of our and other peoples' preferences for granted.

use a Cobb-Douglas specification for the household production function, while Kooreman & Kapteyn (1987) use the indirect translog utility function as a specification for their model. A disadvantage of this approach could be that results may be sensitive to the specific functional form chosen (see Gronau 1986, p. 285).

The second approach is to specify specific functional forms for the equilibrium conditions of the household production model. This approach is taken in Gronau (1980). In his model in equilibrium, there is an equality for persons with paid work between the marginal productivity of work at home, the marginal rate of substitution between leisure and income (the reservation wage), and the market wage rate. Gronau then specifies a functional form for the home production function, from which the equation for work at home is derived.

The empirical results presented in Gronau (1980) suggest that in the U.S. the value of household production is approximately 70% of household income after tax. For households with young children, the value of household production is about equal to family income after tax. For women with young children, the loss of household production when the woman enters the labor market almost equals the net earnings from paid work. Gronau (1980) also finds that the value of household production increases with education, but the increase in the value of household production with education is less than the increase in the market wage with education.

Graham & Green (1984) conclude from their empirical findings that the elasticity of household production with respect to market goods is larger than the elasticity with respect to the time spent on household production. They also conclude that there are no economies of scale in household production, and that for both men and women human capital is more productive in market work than in housework.

Kooreman & Kapteyn (1987) find that the presence and age of children have a large effect on the time women spend on the care of children. The presence of children reduces the time spent on entertainment and social activities. However, the allocation of time by the husband is hardly affected by the presence of children.

Some empirical studies of the allocation of time within a household production framework suffer from one or more of three potential drawbacks: 1) restrictive functional forms, 2) a limited number of time use categories, or 3) no correction for selection bias.

Only a few studies distinguish more than two categories of time use. Most only distinguish between time spent on housework and `pure' leisure. An exception is Kooreman & Kapteyn (1987) which distinguishes seven types of leisure activities: 1) household activities, 2) child care, 3) obtaining goods and

services, 4) personal needs and care (including sleeping), 5) organizational activities, hobbies and sports, 6) entertainment and social activities, and 7) radio, television, reading books etc. Gronau (1980) and Graham & Green (1984) estimate the coefficients of one activity equation: female housework.

Estimation of allocation of time models on the basis only of individuals in paid employment introduces a selection bias. Gronau (1980) and Graham & Green (1984) ignore selection bias, while Kooreman & Kapteyn (1987) use a two-step estimation method to correct for it.

In the household production model estimated in Section 6, we correct for selection bias (cf. Appendix A) due to non-participation in paid employment. We use three categories of time use: market work, housework and child care. Finally, we avoid the problems of restrictiveness of functional forms of the household production function by using the equilibrium conditions as a starting-point for the empirical implementation of the model.

5 Explaining child characteristics

In this section, we attempt to identify the determinants of child characteristics. Child characteristics can be seen as an aspect of `child quality'. Willis (1971,1973) presents a household production model in which one factor determining the utility of the household is the total quantity of child services. The quantity of child services is defined as the product of the number of children and the quality per child. The quality of the child is defined as the child services produced within the household from which the household derives utility. The quality per child is generated within the household by a production function with market goods and time as inputs. The household chooses the number of children, the amount of quality of the children, and the amount of other commodities in order to maximize their life-time utility function, subject to a budget and a time restriction. Using this assumption of optimizing behavior, it is possible to derive the demand function for the number of children as a function of the woman's labor supply, total married life-time, total life-time income and the amount of initial human capital. In a similar manner, it is possible to derive the demand equations for the quality of children.

In empirical applications of Willis' household production model, the quality of children is usually neglected due to lack of relevant data. Our data contains unique information on the following six child characteristics: the boisterousness of the child(ren), whether they are obedient or not, whether they demand a lot of attention, their sleeping behavior, their health, and whether

they have any other peculiarities because of which they need more attention. From this information we constructed the following variables: a dummy variable if any of the children is boisterous, a dummy if any of the children is disobedient, a dummy if any of the children demands a lot of attention, a dummy if any of the children sleeps poorly, a dummy if any of the children is frequently ill, and a dummy if any of the children has any other peculiarities.

As explanatory variables we use the human capital, time input, labor market status and income variables suggested by the theory of the New Home Economics. More specifically, we estimate probit equations for the six child characteristics separately using the following explanatory variables: years of education of the woman, her age, a dummy indicating whether she participates in the labor market, the number of hours spent on child care by the woman, and the sum of the earnings of the husband and the non-labor income of the household.

Table 3
Probit estimates child characteristics (t-values in brackets)

dependent variable:	child boisterous	child not obedient	child needs attention	child has sleeping problems	illness child	child has other peculiarities
intercept	2.091**	1.349	1.808**	3.885**	-0.306	0.676
	(3.479)	(1.579)	(3.023)	(4.780)	(0.400)	(1.119)
years of education	0.034	-0.028	0.063**	0.069*	0.008	-0.007
	(1.464)	(0.763)	(2.655)	(2.357)	(0.246)	(0.308)
age	-0.081**	-0.057**	-0.079**	-0.113**	-0.024	-0.038**
	(5.736)	(2.890)	(5.697)	(6.239)	(1.393)	(2.736)
participates in labor market	-0.013	-0.486*	-0.166	-0.109	-0.252	-0.129
	(0.095)	(2.345)	(0.117)	(0.606)	(1.338)	(0.898)
hours spent on child care	0.003	0.002	0.010	0.025**	0.000	0.004
	(0.614)	(0.322)	(1.738)	(3.076)	(0.064)	(0.773)
income/1000	0.149	-0.499	0.150	-0.254	-0.215	0.226
	(0.801)	(1.724)	(0.803)	(1.126)	(0.837)	(1.186)
Loglikelihood	-238.908	-105.904	-232.864	-133.583	-123.261	-255.195
Pseudo-R^2	0.124	0.064	0.175	0.394	0.017	0.037
Percentage positive observations	0.44	0.09	0.54	0.80	0.10	0.29

* significant at 5% level; ** significant at 1% level

Sleeping problems are the most frequently reported: 80% of the women indicate that they have at least one child with sleeping problems. More than half the women (54%) have children who demand a lot of attention, while 44% have children who are boisterous. Comparatively few women report having children who are frequently ill (10%) or disobedient (9%).

Age of the woman is the only variable that is significantly different from zero in all but one of the probit equations. The only exception is the child illness equation, where none of the variables has a significant effect. Whether or not children are frequently ill is not determined by characteristics of the mother, but probably by other - more physical - characteristics of the children themselves.

The coefficient of the age variable is negative in all equations, indicating that older women have fewer problems with their children. Years of education increase problems with children demanding attention problems and sleeping poorly. Participation in the labor market has an effect only on the obedience of the child. The sign of the effect indicates that women who participate in the labor market have more obedient children.

Hours spent on child care have no effect on child quality (except for sleeping problems), nor has income.

The result concerning age of the woman, can be seen as a confirmation of Willis' theory of household production: older women possess more human capital, have better quality children and experience fewer problems with them. In this sense the household production explanation that there is a causality from mother's characteristics to child quality can be confirmed. However, a more direct explanation for the negative age effects could be that older women are more experienced in raising children and/or are more patient. The fact that the self-reported quality of the child by the mother varies systematically with characteristics of the mother indicates that child quality is not exogenous. The results obtained for the child illness equation, where none of the variables has a significant effect, confirms this notion. The reported characteristics of the child are probably a mixture of the perceptions of the mother and the `true' characteristics of the child.

In the next section, the child quality variables are included in the time allocation model and used to explain time spent by the mother on caring for her children.

From the probit estimates we can conclude that there is no simultaneous relation between quality of the child and time spent on child care by the mother.

6 Household production and time allocation

The model developed in this section assumes that women can derive utility from three goods: leisure, child care services and other commodities. Commodities are `produced' by women by combining market goods and time inputs. Child care services are measusred in time input by the mother, hence these services are valued through the mother's time only. The woman maximizes her utility subject to two restrictions: a time restriction and a budget restriction. Utility maximization yields the equilibrium conditions. These conditions state that in equilibrium the marginal value of housework and the marginal rate of substitution between child care time and consumption by the mother equal the market wage rate. Moreover, in equilibrium the reservation wage equals the market wage rate. Following Heckman (1974) and Gronau (1980), we specify functional forms for the market wage rate, the reservation wage, the marginal value of housework and the marginal rate of substitution between child care and consumption. From these equations we derive the equations for the time allocation on paid work, housework and child care by the mother. In the econometric specifications we show how these three time allocation equations can be estimated jointly and how we account for possible selection bias due to non-participation in the labor market.

6.1 The household production model[3]

Assume that a woman's preferences for consumption, child care services and leisure can be described by a utility function U:

$$U = U(Z, H_c, L) \qquad (1)$$

where Z represents the consumption of commodities in the household by the woman, L is the amount of her leisure consumed and H_c is the time spent on child care by the mother.

Commodities within the household are produced by combining market goods (X) and time inputs (H_Z). We assume that household production technology can be represented by a production function, where input factors X and H_Z are used to produce Z:

$$Z = Z(X, H_Z) \qquad (2)$$

We assume the following functional form for Z:

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[3] Readers who are not interested in technical details can skip this section, without loss of information.

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$$Z = X + Z(H_Z) \tag{2a}$$

Commodities Z consist of goods bought at the market plus goods produced by the time inputs of the woman in housework.

The woman is confronted with two restrictions on her behavior: a budget restriction and a time restriction. The budget restriction is given by:

$$X = WN + \mu \tag{3}$$

where μ is non-labor income (including earnings of the spouse), W is the real wage rate and and N is the number of hours of paid labor. The price of market goods is normalized to one. The time restriction is:

$$L + N + H_c + H_z = T \tag{4}$$

where T is the total time endowment.

If we substitute the time constraint (4) into the budget constraint (3), and re-arrange we get:

$$X = W(T - L - H_c - H_z) + \mu \tag{5}$$

or

$$X + WL + WH_c + WH_z = WT + \mu \tag{6}$$

where $WT + \mu$ is full-income, i.e. the virtual income available for allocation between income, household work, child care and leisure.

The woman allocates her full-income over commodities, leisure, child care and housework in order to maximize her utility or welfare level, i.e. she maximizes the utility function (equation 1) under the budget and time restrictions (equation 6). The Lagrange equation for this optimization problem is:

$$L = U(Z(X, H_z), H_c, L) + \lambda(Y - X - WL - WH_c - WH_z) \tag{7}$$

where Y is full-income.

Maximization of the utility function yields the first order or equilibrium conditions of the model:

$$(\partial U / \partial Z)(\partial Z / \partial X) = \lambda \tag{8}$$

$$(\partial U / \partial Z)(\partial Z / \partial H_z) = \lambda W \tag{9}$$

$$(\partial U / \partial H_c) = \lambda W \tag{10}$$

$$(\partial U / \partial L) = \lambda W \tag{11}$$

Combining (8) and (11) yields:

$$(\partial U/\partial L)/[(\partial U/\partial Z)(\partial Z/\partial X)] = W \qquad (12)$$

From equation (2a) we see that $\partial Z/\partial X = 1$, hence equation (12) can be rewritten as:

$$(\partial U/\partial L)/(\partial U/\partial Z) = W \qquad (12a)$$

$(\partial U/\partial L)/(\partial U/\partial Z)$ is the marginal rate of substitution between leisure L and commodities Z.

Combining (8) and (9) yields:

$$[(\partial U/\partial Z)(\partial Z/\partial H_z)]/[(\partial U/\partial Z)(\partial Z/\partial X)] = W \qquad (13)$$

or

$$(\partial Z/\partial H_z) = W \qquad (13a)$$

where $(\partial Z/\partial H_z)$ is the marginal value of household work.

Finally, combining (8) and (10) yields:

$$(\partial U/\partial H_c)/[(\partial U/\partial Z)(\partial Z/\partial X)] = W \qquad (14)$$

or

$$(\partial U/\partial H_c)/(\partial U/\partial Z) = W \qquad (14a)$$

where $(\partial U/\partial H_c)/(\partial U/\partial Z)$ is the marginal rate of substitution between child care time and commodities.

For the empirical implementation of the model we can specify either functional forms for the household production functions (2) and utility function (1) or specify functional forms for the marginal rates of substitution expressions in equation (12a), (13a) and (14a). In this chapter we take the latter approach (see Gronau, 1980).

Let $MV_z = (\partial Z/\partial H_z)$ be the marginal value of housework; $MRS_c = (\partial U/\partial H_c)/(\partial U/\partial Z)$ is the marginal rate of substitution between child care time and commodities. Further, let $MRS_r = (\partial U/\partial L)/(\partial U/\partial Z)$ be the marginal rate of substitution between leisure and commodities or the reservation wage.

For the wage equation we follow the standard Mincerian semi-logaritmic specification:

$$\text{Log } W = Y_w\beta_w + \varepsilon_w \qquad (15)$$

where the log of the net wage rate W is a function of human capital variables Y_w with associated coefficient β_w, and ε_w is a random term capturing unmeasured and unmeasurable variables.

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For the reservation wage, we specify the following equation:

$$\text{Log MRS}_r = Y_r \beta_r + \alpha_r N + \varepsilon_r \tag{16}$$

where Y_r is a vector of individual characteristics with coefficient β_r. The level of the reservation wage further depends on the number of hours of paid labor N with coefficient α_r. This specification of the reservation wage corresponds to the Heckman (1974) approach to modelling labor supply. The inverse of the coefficent α_r measures the wage effect on hours of paid labor.

For the marginal value of housework, we specify the following equation:

$$\text{Log MV}_z = Y_z \beta_z + \alpha_z H_z + \varepsilon_z \tag{17}$$

We assume that the marginal value of household time depends on individual characteristics (Y_z) and the time spent on housework (H_z). The inverse of α_z measures the productivity effect on the time spent on housework.

For the marginal rate of substitution between child care time and commodities, we specify:

$$\text{Log MRS}_c = Y_c \beta_c + \alpha_c H_c + \varepsilon_c \tag{18}$$

The log of the marginal rate of substitution between time spent on child care by the mother and commodities is a linear function of characteristics of the child (Y_c) and the time spent on child care (H_c).

Using the equilibrium condition (12a, 13a, and 14a), we can derive the time allocation equations for women who participate in the labor market. The equation for the supply of paid labor hours is found by equating equations (15) and (16):

$$\text{Log MRS}_r = \text{Log W}$$
$$Y_r \beta_r + \alpha_r N + \varepsilon_r = Y_w \beta_w + \varepsilon_w \tag{19}$$

and solve for N - the number of hours of paid labor. This yields the supply of paid labor hours equation for the individual:

$$N = (Y_w \beta_w - Y_r \beta_r + \varepsilon_w - \varepsilon_r)/\alpha_r \tag{20}$$

To derive the equation for the time spent on housework, we use the equality between the log of the marginal value of housework (log MV_z) and the log of the market wage rate (log W) in equilibrium (equations 15 and 17). From this, we derive that:

$$H_z = (Y_w \beta_w - Y_z \beta_z + \varepsilon_w - \varepsilon_z)/\alpha_z \tag{21}$$

In the same way, we derive the equation for the optimum hours of child care for the woman from the equality between log MRS_c and log W:

$$H_c = (Y_w\beta_w - Y_c\beta_c + \varepsilon_w - \varepsilon_c)/\alpha_c \qquad (22)$$

6.2 Descriptive statistics

Table 4 contains the average sample values of the actual and preferred allocation of time of employed women (in hours per week). The average period of paid employment of the women participating is 19 hours per week. Employed married women with children spend an average of 32 hours per week on household activities and 23 hours on child care. If we compare the average preferred allocation of time with the average actual allocation, we note that women would prefer to increase their labor supply and hours spent on child care, while reducing their hours of housework (cf. table 1).

Table 4
Actual and preferred time allocation of employed women with children (average sample values of hours per week, standard errors in brackets)

	actual allocation of time	preferred allocation of time
paid labor	19.33 (11.45)	21.29 (8.93)
housework	31.59 (11.91)	28.26 (14.25)
child care by the mother	22.94 (11.92)	25.74 (15.62)
#observations	187	150

In the wage equation we use human capital variables as years of education, years of actual labor market experience, experience squared. De vector Y_w includes: years of education, years of work experience, experience squared and a dummy for whether the woman has had an interruption period from the labor market.

In the reservation wage equation, we include the variables: income of partner and non-labor income, number of children aged 0-3 years, number of children aged 4-12 years, number of children aged 13-18 years, number of children over the age of 18 and hours in the market. By including the labor earnings of the husband in the reservation wage equation, we implicitly assume a so-called `male chauvinist' decision structure in the household, in which the

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woman is the secondary worker in the household: the male partner determines his hours of paid work irrespective of his wife's allocation of time and the wife adjusts her hours of paid labor to suit her husband's decision. The same holds for time spent on child care and time spent on housework.

The equation for the marginal value of housework includes other household income, number of children aged 0-3 years, number of children aged 4-12 years, number of children aged 13-18 years, and number of children over the age of 18.

The equation for the marginal rate of substitution between child care and commodities includes the following variables: other household income, number of children aged 0-3 years, number of children aged 4-12 years, number of children aged 13-18 years, and number of children over the age of 18. We also include variables for the quality of the child as used in Section 5: a dummy variable if any of the children is boisterous, a dummy if any of the children is disobedient, a dummy if any of the children demands a lot of attention, a dummy if any of the children has a sleeping problem, a dummy if any of the children is frequently ill, and a dummy if any of the children has any other peculiarities because of which it needs more attention.

Table 5

Parameter estimates of the time allocation model (t-values in brackets)

	actual allocation of time	preferred allocation of time
Market wage equation		
intercept	1.645***	1.672***
	(16.097)	(12.908)
years of education	0.032***	0.034***
	(7.677)	(7.697)
experience	0.059***	0.048***
	(6.105)	(3.404)
experience^2/100	-0.163***	-0.107**
	(5.067)	(2.366)
interruption period	0.078**	0.048
	(2.415)	(1.362)
Reservation wage equation		
intercept	1.347***	0.678
	(3.009)	(0.659)
other income in household/1000	0.150	0.002
	(0.795)	(0.090)
number of children aged 0-3 years	0.278	0.326
	(1.522)	(1.111)

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number of children aged 4-12 years	0.221 (1.494)	0.174 (0.778)
number of children aged 13-18 years	0.056 (0.385)	0.002 (0.085)
number of children over 18 years	-0.044 (0.203)	@
market time (α_r)	0.046*** (3.078)	0.078* (1.936)
Marginal value of housework		
other income in household/1000	0.032 (0.099)	0.189 (0.351)
number of children aged 0-3 years	-0.042 (0.159)	-0.278 (0.625)
number of children aged 4-12 years	-0.443 (1.531)	-0.291 (0.821)
number of children aged 13-18 years	-0.293 (0.983)	-0.589 (1.304)
number of children over 18 years	-0.657 (1.352)	@
time spent on housework (α_z)	0.095*** (6.320)	0.104*** (4.061)
Marginal rate of substitution **between child care and commodities**		
other income in household/1000	-0.185 (0.646)	0.015 (0.027)
number of children aged 0-3 years	-1.488*** (3.889)	-1.298** (1.986)
number of children aged 4-12 years	-0.553** (2.057)	0.321 (0.798)
number of children aged 13-18 years	0.800*** (3.726)	0.651 (1.562)
number of children aged over 18 years	0.643 (0.966)	@
child boisterous	0.212 (0.949)	-0.053 (0.168)
child disobedient	-0.382 (1.334)	-0.585 (0.775)
child demands attention	-0.060 (0.239)	0.633* (1.697)
child has problems sleeping	0.466 (1.535)	-0.740 (1.037)
illness of child	0.249 (0.624)	0.520 (0.683)

child has other peculiarities	0.084	-0.112
	(0.346)	(0.278)
time spent on child care (α_c)	0.115***	0.108***
	(7.283)	(3.631)
Covariance matrix		
σ_w	0.371***	0.389****
	(71.754)	(62.085)
σ_r	0.393*	0.550
	(1.683)	(1.200)
ρ_{wr}	0.113	0.054
	(1.116)	(0.434)
σ_z	0.930***	1.289***
	(4.718)	(3.216)
ρ_{wz}	-0.226**	-0.127
	(1.965)	(0.905)
σ_c	0.890***	1.252***
	(5.241)	(3.210)
ρ_{wc}	0.005	0.011
	(0.042)	(0.076)
#observations	178	147
loglikelihood	-1214.06	-1080.25

* significant at 10% level; ** significant at 5% level; *** significant at 1% level
due to lack of observations, `number of children over 18 years' was aggregated with `number of children aged 13-18 years'.

7 Estimation results of the time allocation model

The parameter estimates are given in table 5. The rate of return to education is approximately 3%. The effect of education on market wages is similar in terms both of the actual allocation of time and the preferred allocation. Experience has an inverse U-shaped effect on market wages, as expected. The experience-wage profile in the actual allocation of time model is a little steeper than in the preferred allocation of time model. In the actual hours model, the dummy variable for a period away from the labor market is positive, indicating that those who have been unemployed or out of the labor force for a while have higher wages than those who have not. In the preferred hours model, the interruption dummy is not significant.

Other income in the household has an insignificant effect in all three equations. This suggests that the time allocation of the mother is independent of the earnings of the husband and other non-labor income. This finding does suggest that the `male chauvinist model' does not hold.

Children have a significant effect on the marginal rate of substitution between child care by the mother and commodities but not on her reservation wage or on the marginal value of housework. Young children - aged between 0 and 3 and between 4 and 5 years -decrease the marginal rate of substitution of child care and increase the time spent on child care by the mother. The presence of older children decreases the time spent on child care by the mother. An explanation for these negative effects of older children may be that older children take over some of the care for younger children from the mother. In the actual hours model, a child aged between 0 and 3 decreases the marginal rate of substitution of child care by almost 150%, while a child aged between 4 and 5 decreases the marginal rate of substitution of child care by 55%. A child aged between 6 and 12 years increases the marginal rate of substitution of child care by 80%.

The estimation results do not show that there are economies of scale associated with household size. Children have no effect on time spent on housework, but young children do have a major effect on time spent on child care. The time spent on child care by women with young children is at the expense of their leisure time, not at the expense of labor supply.

The demographic effects in the preferred hours model are less than in the actual hours model. Perhaps women more or less ignore the presence of children in determining their preferred allocation of time.

The characteristics of the children all have an insignificant effect on the time spent on children.

In the actual hours model, an hour of paid work raises the reservation wage by 4.6%, while in the preferred hours model the figure is 7.8%. The inverse of the hours of work coefficient measures the wage effect on hours of paid labor. A 1% increase in the hourly wage rate implies that the actual hours of paid employment per week increase by a little less than a quarter of an hour, while the preferred hours of work increase by approximately 8 minutes. Calculated in the mean value of the actual hours of work variable (19 hours per week) the wage elasticity of actual labor supply is 1.14. In the preferred hours of work model, the wage elasticity of labor supply is 0.61. Separating household and child care activities from leisure time does not change the wage elasticity of labor supply.

An hour of housework increases the marginal value of housework by 9.5% in the actual hours model, and by 10.4% in the preferred hours model. In the average value of actual hours spent on housework (32 hours per week), the elasticity of housework with respect to the marginal value of housework is 0.329. A 1% increase in the marginal value of housework increases the time spent on this activity by 3.3%. In the preferred hours model, the marginal

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value elasticity of housework is 0.343 (calculated in the mean value of the preferred hours of housework).

An hour of child care increases the marginal rate of substitution between child care and commodities by approximately 11%. In the average hours of child care (23 hours per week in the actual hours allocation and 26 hours in the preferred hours distribution), the marginal rate of substitution elasticity of child care time is 0.378 in the actual hours model and 0.356 in the preferred hours model. A 1% increase in the marginal rate of substitution between child care and commodities increases the time devoted to child care by approximately 3.7%.

The variance of the marginal value of housework and the variance of the marginal rate of substitution between child care and commodities are substantially higher than the variance of the market wage equation. *This suggests that women differ more in the value they attach to housework and child care services than in the value of market work.* The variance of the reservation wage equation is almost equal to that of the market wage equation.

The correlation coefficients between the market wage equation and the reservation wage equation and between the market wage equation and the marginal rate of substitution between child care and commodities equation are both positive but insignificant. The correlation coefficient between the market wage equation and the marginal value of housework equation is significantly negative: a higher market wage is associated with a lower marginal value of housework.

8 Replication on other data-sets

A similar time allocation model has been estimated on another data-set (see Groot & Maassen van den Brink in OSA 1994 for a detailed description of these results). There are a few notable differences between these data and those used in the previous section of this paper:
1) in the former data (OSA, 1994), four activities are distinguished instead of three: paid employment, housework, child care and care of the spouse;
2) in the replication studies, we used information on both employed and non-employed individuals;
3) in the replication studies, we used information not only on women but also on men;
4) the replication data do not contain information on the preferred allocation of time;

5) the replication data do not contain information on the quality of children;
6) the replication estimates are on women aged between 24 and 46, married or cohabiting with a male partner, and with children (and on their partners);
7) the number of observations in the empirical analysis of the replication data is much larger (1,488 women and 1,094 men).

The allocation of time model in the replication study is estimated for women and men separately. For both sexes, two sets of equations are estimated: one including the time spent by the spouse on the activities distinguished, and a specification without the spouse's allocation of time as an explanatory variable. Including the spouse's allocation of time has little or no impact on the effects of other variables.

Most findings from the replication confirm the conclusions drawn in the previous section. Most of the coefficients of the time spent by the woman on the activities distinguished (the α's) are a little lower, but have the same signs as those presented in this paper.

In general we find that for women the α's for care of the spouse, housework and child care are significantly less than one. The calculated wage elasticity of married women's labor supply is therefore also a little higher in the replication (1.2 in the mean value of the hours of work variable vs. 1.1 in the previous section of this paper).

The replication finds strong effects of the presence of young children on the reservation wage, but not on the time spent on housework and child care. Non-labor income and earnings of the partner have an insignificant effect on the allocation of time.

If we compare the results for women with those for men, we can draw the following conclusions:
1. The labor supply behavior of women is independent of male labor supply. Male labor supply, on the other hand, increases with the hours of paid work performed by the women.
2. The presence and age of the children has a major effect on the women's allocation of time, but no effect on male time allocation. Similar findings are reported by Kooreman & Kapteyn (1987).
3. The wage elasticity of female labor supply is greater than the own wage elasticity of male labor supply. However, the elasticity of the male value of household time and child care are much greater than those of the women. This implies that the allocation of male time to housework and child care is much more sensitive to the value of the individual's household production and child care than is the case with female time

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allocation, while female labor supply is more sensitive to the value of market time (wage rate) than is the case with male labor supply.

4. For both partners, the time spent on care *of* the partner increases with the time spent on care *by* the partner: if she spends more time on him, he spends more time on her. The same holds for household time and child care: time spent by the female on these activities increases the time spent by the male on them. Non-market time of the partners in the household are complements. For the male partner, market time of both partners are also complements, while for the female partner the market time of each partner is independent.

9 The value of market and non-market production

The value of household production and the value of child care provided by the mother is calculated by means of the `opportunity costs approach'. The value of non-market production is determined by the market wage rate. The calculated value says something about the value of alternative time use (time spent on non-market activities instead of market activities). The calculated values of total production do not express judgements about quality of household care and child care (cf. Appendix B).

Table 6

Mean values of market and non-market production for employed women with children aged below 18, in NLG per week

	all women with children below 18	women with children aged 0-3 years	women with children aged 4-12 years	women with children aged 13-18 years
actual allocation of hours				
labor earnings	248	213	233	281
value of market work	219	207	214	231
value of household production	245	237	245	267
value of child care	170	194	166	144
total value of production	633	639	624	642
#observations	178	67	108	60
preferred allocation of time				
labor earnings	277	240	271	214
value of market work	180	176	173	193
value of household production	452	434	507	483
value of child care	996	2161	238	147
total value of production	1628	2770	918	823
#observations	143	57	86	49

The estimations of the value of (household) production are given in table 6. The value of production is calculated for each women in our sample individually. The values in table 6 are the sample means of the individual values of production.

Table 6 shows that the value of non-market production (household production and child care) is substantial and exceeds that of market production. We also find that using the preferred hours model substantially increases the value of production. The expected labor earnings for all women with children below 18 are 248 guilders in the actual hour equation and 277 guilders in the preferred hours equation. For all women with children below the age of 18, the total value of production is 633 guilders per week using the actual allocation of time, and 1,628 guilders per week based on the preferred hours distribution. Therefore, reducing the (institutional) constraints on the allocation of time has a substantial welfare effect (although it is somewhat remarkable that in general women prefer to extend their - and their husbands' - total working hours of market and non-market work at the expense of leisure time).

The value of market work based on the actual hours distribution is higher than that based on the preferred hours distribution. This may indicate that women would like to reduce their hours of market work. Both the value of household production and the value of child care are higher using the preferred allocation than if based on the actual allocation. In particular, the value of child care increases if we use preferred hours.

The value of market work increases with the age of the children. In the actual hours calculations, the value of market work is 207 guilders per week for women with children aged 0-3 years and 231 guilders for women with children aged 13-18. This is probably an effect of experience: women with older children (potentially) possess more human capital due to their greater (potential) labor market experience. This increases the value of their market work.

The value of child care decreases with the age of children. In the actual hours distribution, the value of child care is 194 guilders for women with children aged 0-3 years and 144 guilders for women with children aged 13-18. This reflects the reduction in time spent on child care as the children get older.

In order to gain greater insight into the results, we have calculated the expected value of market and non-market production for three types of women: a `full-time homemaker', a woman who has part-time market work, and a woman who has full-time market work. Each of these three types of women is assumed to allocate 70 hours per week to a combination of market work, housework and child care. A woman - oriented towards non-market work - is defined as a woman who does not perform market work, who works 40 hours a week in the household and spends 30 hours a week on child care. A part time working woman works 20 hours a week in the labor market, spends 30 hours on housework and 20 hours on caring for her children. These values roughly correspond to the mean values in our sample. A woman - oriented towards

market work - works 40 hours a week on the labor market, spends 10 hours on housework and 20 hours a week on child care. For each of these three women we have calculated the value of market and non-market work setting the exogenous variables at their respective average values.

Table 7
Expected value of market and non-market production for three household types, in NLG per week

	full-time home maker	woman part-time market work	woman full-time market work
actual allocation of time			
labor earnings	0	259	517
value of market time	0	179	630
value of household production	309	115	11
value of child care by mother	195	57	57
total value of production	504	351	698
preferred allocation of time			
labor earnings	0	250	501
value of market time	0	120	689
value of household production	409	140	12
value of child care by mother	197	62	62
total value of production	606	232	763

The results in table 7 show that the total value of market and non-market production is highest for women who specialize in market work. Using the actual hours of work estimates, the total value of production for the woman who is in fulltime paid employment is 698 guilders per week. Of course, it must be kept in mind that this woman has to buy on the market services such as non-parental child care, house cleaning, etc. The total value of production for the `fulltime homemaker' woman is also high as compared with that of the woman who has a parttime job. In fact, if this woman (parttime market work) has to buy on the market services such as non-parental child care, her total welfare is probably the lowest of the three.

In a Dutch study (Bruyn-Hundt, 1985) conducted in the mid-eighties, the value of home production was calculated on the basis of women's average gross hourly wage rate. The value of household production for a standard household of an adult female, an adult male and children was a gross 3,350 guilders a

month (with calculations being based on the average time spent on housework by all women). In our calculations, the value of household production is about 1,860 guilders a month (net) for women who are in the labor market and have children. It is conceivable that the reason why these calculations are somewhat lower is that we took account of substitution between market work, housework and child care. Besides, our calculations were made for mothers who are in the labor market and spend less time doing housework. If we compare our calculations for a `fulltime homemaker', total value of production is about 2,268 guilders a month (net), an approximation of the gross monthly sum of 3,350 guilders mentioned previously. In both studies, therefore, the value of household production is substantial.

10 Conclusions and discussion

Women who are in the labor force would prefer to spend more time with their children, while women who are full-time homemakers would prefer to have part-time jobs averaging 10 hours per week. All women, irrespective of the type of household they are in would prefer their partners to spend more time caring for the children.

In dual-earner households without children, there is an equality in the time allocated by the two partners to market and non-market work: on average, these men spend the same amount of time doing housework as their spouses. The presence of a child in the household produces an inequality; women then spend more time on housework and caring for the children than men, and less time in the market.

Both women and men are rationed in their optimal allocation of time, especially with regard to non-market work (this is so, at least, if we give credence to the views of the female respondents on their partners' preferred time allocations).

For the time allocation the wage elasticity of actual labor supply of the woman, calculated in the mean value of the actual hours of work, are 1.14. Calculated in the preferred hours of work, the wage elasticity for the model is 0.63 and 0.61 respectively. Considering the allocation of leisure to different types of non-market work in the time allocation model does not seem to affect the estimates of labor supply elasticities. The theoretical model originally put forward by Mincer (1962), in which the value of home production is equal to market wage rate + opportunity costs (for example, search and travel costs associated with paid employment), has - to our knowledge - never been estimated. An important point for future research is to take account of all the

opportunity costs of paid employment in estimating the value of home production. Time allocation models provide a framework in which the value of household production can be estimated and the division of non-market time into different uses like child-rearing, housework, etc. can be analyzed. In this respect, time allocation models are to be valued.

The estimates of the demand for `child quality' equations show that older women experience fewer problems with their children. It is remarkable, however, that 80% of the women report having a child with sleeping problems. Women who are in the labor market have more obedient children. The characteristics of the children all have an insignificant effect on the time spent on children in the estimations of the household production model.

We found no results to confirm that the `male chauvinist model' -husband decides/woman adjusts- holds. Other income in the household has an insignificant effect in all three equations estimated in the household production model. In the replication study, the labor supply behavior of women is independent of male labor supply. For the male partner, market time of both partners are complements, while for the female partner the market time of the partner is independent. These results seem at variance with (most) other results. Reality is more complicated than reflected in the male chauvinist model. If a woman's working hours increase, working hours of the father also increase. Probably fathers do not prefer to spend their time alone at home caring for the children. Mother's time allocation is independent of the father's time allocation. This reflects probably her attitude (and his attitude not to be involved) to settle child care arrangements by herself (Maassen van den Brink, 1994). However, the results could also reflect a `liberated' view of Dutch males and an autonomous way of life of Dutch women.

The value of household production is substantial and increases still further if calculations are based on preferred hours. The total value of production of the woman who has fulltime market work is greater than that of either the full-time homemaker or the woman in part-time paid employment. The total welfare of this latter woman is probably the lowest of the three.

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APPENDIX A

The econometric analysis

For the econometric analysis, we assume that the error terms ε_i ($i = w, r, z, c$) are jointly standard normal distributed with correlation coefficients ρ_{wj} ($j = r, z, c$). This implies that $\varepsilon_w - \varepsilon_j$ are standard normal distributed with mean zero and variance $\sigma_w^2 + \sigma_j^2 - 2\rho_{wj}\sigma_w\sigma_j$, where σ_w^2 is the variance of the wage equation and σ_j^2 is the variance of the j-th marginal rate of substitution equation ($j = r, z, c$).

The model is estimated by the maximum likelihood method. We used data from the stratified sample, we used only of women in paid employment. We therefore correct in our likelihood function for this selection bias. For non-participating women the reservation wage exceeds the market wage rate at zero hours of work ($N = 0$).:

$$(Y_w\beta_w - Y_r\beta_r + \varepsilon_w - \varepsilon_r)/\alpha_r < 0 \tag{23}$$

If we use only participating women we have to condition on the fact that at zero hours of work, the inequality in equation (23) is positive.

The log likelihood function is:

$$\text{Log } L = \log[b((\varepsilon_w - \varepsilon_r)/\alpha_r, \varepsilon_w)] + \log[b((\varepsilon_w - \varepsilon_z)/\alpha_z, \varepsilon_w)] + \log[b((\varepsilon_w - \varepsilon_c)/\alpha_c, \varepsilon_w)] - \log[\Phi((Y_w\beta_w - Y_r\beta_r)/\sqrt{(\sigma_w^2 + \sigma_r^2 - 2\rho_{wr}\sigma_w\sigma_r)})] \tag{24}$$

where $b(.,.)$ is the bivariate normal density function, $\Phi(.)$ is the univariate normal distribution function, and:

$$(\varepsilon_w - \varepsilon_j)/\alpha_j = H_j - (Y_w\beta_v - Y_j\beta_j)/\alpha_j \qquad (j = r, z, c)$$

and $\tag{25}$

$$\varepsilon_w = \log W - Y_w\beta_w$$

The bivariate normal distribution function is characterized by:

$$E((\varepsilon_w - \varepsilon_j)/\alpha_j)^2 = (\sigma_w^2 + \sigma_r^2 - 2\rho_{wr}\sigma_w\sigma_r)/\alpha_j^2$$

and $\tag{26}$

$$E(\varepsilon_w)^2 = \sigma_w^2$$

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Calculation of the total value of production

Using the parameters, it is possible to estimate the value the woman attaches to market work (VMW):

$$VMW = {}_0\!\int^N MRs_r(t)\, dt = {}_0\!\int^N \exp(Y_r\beta_r + \alpha_r t)dt \tag{21}$$
$$= \exp(Y_r\beta_r)(\exp(\alpha_r N) - 1)/\alpha_r$$

It is assumed that the value of market work is zero if the woman does not participate in the labor market. We can compare this with the earnings received from doing market work. These earnings are calculated by multiplying the hours of market work N with the wage rate W.

In a similar way as the VMW, we can estimate the value of household production (VHP):

$$VHP = {}_0\!\int^{Hz} MV_z(t)\, dt = {}_0\!\int^{Hz} \exp(Y_z\beta_z + \alpha_z t)dt \tag{23}$$
$$= \exp(Y_z\beta_z)(\exp(\alpha_z H_z) - 1)/\alpha_z$$

VHP is the value of the household work measured in the value of the commodities Z.

The value of child care (VCC) is given by:

$$VCC = {}_0\!\int^{Hc} MRS_c(t)\, dt = {}_0\!\int^{Hc} \exp(Y_c\beta_c + \alpha_c t)dt \tag{22}$$
$$= \exp(Y_c\beta_c)(\exp(\alpha_c H_c) - 1)/\alpha_c$$

The value of child care is expressed in terms of the value of the commodities Z that is required by the mother to compensate for a loss in child care time.

Finally, we can calculate the total value of production as the sum of the VMP, VHP and VCC.

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