# LABOUR SUPPLY, HOUSEHOLD PRODUCTION AND INTRA-FAMILY WELFARE DISTRIBUTION

P F Apps and R Rees

No.405

WARWICK ECONOMIC RESEARCH PAPERS

DEPARTMENT OF ECONOMICS

UNIVERSITY OF WARWICK
COVENTRY

# LABOUR SUPPLY, HOUSEHOLD PRODUCTION AND INTRA-FAMILY WELFARE DISTRIBUTION

P F Apps* and R Rees**

No.405

January 1993

* Law School
University of Sydney &
Division of Economics & Politics
RSSS, Australian National
University

** Department of Economics
University of Guelph
Guelph, Ontario
Canada

*This paper was presented at the 1991 ESRC Warwick Economics Summer Research Workshop on 'The Role of the Public Sector in the Mixed Economy.' Sponsored by SPES (EC) and the ESRC (UK; contract number W100-261-005).

LABOUR SUPPLY, HOUSEHOLD PRODUCTION AND INTRA-FAMILY WELFARE DISTRIBUTION $

by

P.F. Apps*

and

R. Rees†

January 1993

Abstract

This paper demonstrates the importance of incorporating household production in the "collective" model of the household and goes on to develop an empirical specification of the model, which is then estimated.

* Law School, University of Sydney and Division of Economics and Politics, RSSS, Australian National University.

† Department of Economics, University of Guelph, Guelph, Ontario, Canada, N1G 2W1

$ This research is supported by a grant from the Australian Research Council. A version of the paper was presented at the 1991 Warwick Economics Workshop on The Role of the Public Sector in the Mixed Economy. This was supported by the SPES (EC) and the ESRC (UK; contract number W100261005).

## 1 Introduction

In a recent paper, Chiappori (1992) extends and interprets his important earlier work (Chiappori, 1988) on the "collective" model of household labor supply. The household is modeled as a pair of individuals with separate utility functions, who arrive at a Pareto efficient allocation of individual consumptions and labor supplies given the market wage rates they face. He shows that the household's decisions can be modeled as if the individuals first shared their combined non-wage income and then maximized their individual utilities subject to separate budget constraints. He then uses this approach to show essentially three things: that the model generates testable restrictions on individual labor supplies; that the observation of labor supplies is sufficient to allow recovery of individual preferences and the household sharing rule (up to an additive constant); and that the standard tools of welfare analysis can be applied to investigate such issues as, for example, the effects of tax changes on individual welfares.

We very much share Chiappori's belief in the importance of retaining the individual as the basic unit of analysis when analyzing household decisions. Indeed, this was the basis of our own work (Apps and Rees, 1988), where the same idea, that the household achieves a Pareto efficient allocation relative to <u>individual</u> utilities, was used to analyze the effects of taxation on welfare. An important difference is that we also utilized a further fundamental insight of Becker (1965): time that is not spent in market labor supply is devoted not only to 'pure leisure' but also to household production. The present paper has a twofold purpose. We first want to extend Chiappori's results to take account of household production, emphasising as we do so that such an extension is absolutely essential <u>both</u> for the recovery of preferences and the sharing rule, <u>and</u> for welfare analysis of the household. Indeed in the latter respect we argue that failure to utilize Becker's insight can give rise to seriously misleading welfare conclusions. Secondly, we present an empirical model of a household which supplies labor both to the market and domestic production, and estimate it. We hope in this to have made some progress in the important task of empirical application of the "collective" model of household behavior.

The paper is organized as follows. In the next section we offer a brief recapitulation of our own and Chiappori's models, and outline the extensions to his results which follow from distinguishing between pure leisure and household production. Following that we specify the empirical model. The next section then discusses data, parameter estimates and interpretation of the results. Section 5 draws the general conclusions.

## 2 The Chiappori and Apps-Rees Models

The essence of the approach in Chiappori (1988) and Apps-Rees (1988) is that the household consists of individuals with their own utility functions who achieve (by some process left unspecified) a Pareto efficient resource allocation. In fact the household is modeled essentially as a two-person economy facing fixed prices, and all the results of general equilibrium theory, specialized to this simple case, are available. For example we can view the "sharing rule" interpretation as a simple corollary of the Second Fundamental Theorem of Welfare Economics.[1] Denoting the individuals by f and m, we can under the Apps-Rees approach define three goods: a market (composite) consumption good x, whose price is unity; a domestically produced good y, whose implicit price is determined within the household since it is not traded externally; and pure leisure, z, whose price is the relevant market wage. Individuals have utilities $u^i(x_i,y_i,z_i)$, $i = f,m$, of the standard kind. Under Chiappori's approach there is no household production and the utilities are $U^i(x_i,z_i)$, $i = m,f$. With exogenously given wage rates $w_i$ and non-wage incomes $m_i$, the problem for the Apps-Rees household is:

$$\text{Max } u^f + \delta u^m \tag{1}$$

$$\text{s.t.} \quad \Sigma x_i \leqslant \Sigma(w_i l_i + m_i) \tag{2}$$

$$\Sigma y_i = y \leqslant h(t_f, t_m) \tag{3}$$

$$l_i + t_i + z_i = T \qquad i = f,m \tag{4}$$

$$l_i \geqslant 0; \quad t_i \geqslant 0; \quad z_i \geqslant 0; \qquad i = f,m \tag{5}$$

where: $l_i$ is time spent supplying labor on the market; $t_i$ is time spent in domestic production; and $h(.,.)$ is the household production function, assumed to be strictly increasing, three times continuously differentiable and strictly quasi-concave. Under Chiappori's formulation the $u^i$ are replaced by $U^i$, (3) does not appear, and $t_i = 0$ in (4 ) and (5). The parameter $\delta$ simply expresses the fact that we are seeking a Pareto efficient allocation of the $x_i$, $y_i$, $z_i$, $t_i$, $l_i$. We assume that there are reservation utilities $u^i$ which must be weakly exceeded if individual i is to remain in the household, and these determine the interval of values from which the $\delta$ in (1) is to be taken. Any actual household allocation can be generated by an appropriate choice of $\delta$ within this interval, given that the allocation is Pareto efficient.

The household allocation is easy to rationalise in neo-classical terms. We can impute a price, p, to the domestic good, which equals its marginal cost of production. If both $l_i > 0$ at the optimum (both work outside the home), this marginal cost is $w_i/h_i$, i = f,m, where $h_i$ is i's marginal product in domestic production. That is, i's time in domestic production will be increased up to the point at which its marginal value product $ph_i$ is equal to its marginal opportunity cost $w_i$. For each i the marginal rate of substitution between leisure and a consumption good equals the ratio of i's wage rate to the price of that good. The efficient allocation of time determines the total output of the domestic good and the total expenditure on the market good (= total wage plus non-wage income), and these total feasible consumptions are then allocated between the two individuals so as to equalize their marginal rates of substitution. In general, the entire allocation will depend on the implicit relative weight on f and m's utilities, which determines the point reached on the "household contract curve".

If one individual, say f, supplies no market labor at the optimum ($l_f = 0$), then we have the weak inequality $ph_f \geqslant w_f$ and her market wage places a lower bound on her marginal value product in domestic production. Since $l_m > 0$ (we ignore the case in which neither individual supplies labor to the market), the implicit price of the domestic good is given by the equality $p = w_m/h_m$ (we also assume that m always supplies some labor to domestic production). Making this allowance for the corner solution, the rest of the interpretation goes through as before.

The solution of the problem will give market labor supplies $l^i(w_f,w_m,M)$, market good demands $x^i(w_f,w_m,M)$, domestic good demands $y^i(w_f,w_m,M)$, and household labor supplies $t^i(w_f,w_m,M)$, where $M = \Sigma m_i$ (it is clear from (2) that given the income pooling implied by this constraint only total non-wage income matters for the solution). The parameters of these functions are derived both from preferences and the household production function.

The labor supply functions estimated from data on the $l_i$, $w_i$ and M would be observationally equivalent to those resulting from Chiappori's approach, in which only preferences determine the allocation of time between market work and leisure. The rationalization of labor supply responses is however different in the two models. For example, in the Apps-Rees model an increase in $w_m$ raises the implicit price of the domestic good, thus inducing a substitution effect against it, but increases household full income, increasing the demand for it if it is normal. In Chiappori's model $w_m$ is more directly the price of m's leisure. It is straightforward to derive restrictions on labor supplies in the Apps-Rees model, but since these are not the main point of interest here that will not be pursued.

If Becker's insight concerning the distinction between pure leisure and time spent in domestic production is correct, and we believe it is, then it is immediately clear that Chiappori's claim, that estimation of market labor supply functions allows retrieval of individual preferences and the household sharing rule (up to an additive constant), does not hold true. The claim is based on the idea that in leisure-consumption space, if we know the leisure co-ordinate of the equilibrium allocation and the slope of an individual's indifference curve (given by the wage-price ratio) then we can integrate to obtain a utility function and further solve to find a sharing rule contingent upon the individual's consumption being somewhere between zero and total household market income. In the Apps-Rees model estimation only of labor supply functions would be insufficient on two grounds. First, knowing $l_i$ alone does not allow i's pure leisure $z_i$ to be calculated (refer to constraint (4)) and so, if we also do not observe individual i's consumption of the market or domestic good we have no co-ordinate in the domain of the utility functions from which to start. Secondly, the domain of the utility function is 3-dimensional; there are three goods, $x_i$, $y_i$, $z_i$ on which utility is defined, and knowledge only of the $z_i$-coordinate and slope of the indifference surface in the $(z_i, x_i)$-plane would not allow solution of the integrability problem.

It might then be tempting to say: so much the worse for the Apps-Rees model, if a more parsimonious model "works" with far less data. The point however is that if one believes that domestic production is a significant empirical phenomenon, as we do, then the results obtained by ignoring it may be empirically inapplicable. To retrieve theoretical constructs such as utility functions and sharing rules from empirical observations requires an intervening theoretical structure, and if this structure is inappropriate then the results can be expected to be inapplicable.

To take an example: in both models, household full income is $Y = T\Sigma w_i + M$. Suppose we observe both the individual labor supplies and consumptions of the market goods, and that $l_f = 0$, $l_m > 0$, $x_f = x_m = x^*$, i.e. a non-working wife consumes as much of the market good as her working husband. The resulting estimates of labor supply and consumption demand functions would in Chiappori's model allow exact derivation of the sharing rule and individual utilities. The individual shares in household full income would be:

$$s_f = (w_f T + x^*)/Y \qquad s_m = (w_m(T - l_m) + x^*)/Y \tag{6}$$

That is, f's entire time is spent consuming pure leisure while she also has one-half the household consumption of the market good. This could be viewed as being achieved by a lump-sum transfer from m to f of $0.5(w_m l_m + M)$. Implicit in the formal approach therefore is a view of the household based not on a division of labor but a division of consumption roles in which one household member is virtually parasitic. Moreover, the sharing rule generated by this model would be used to evaluate policy issues such as changes in tax rates, so the appropriateness of the sharing rule is also relevant for discussion of changes in the household equilibrium.

In the Apps-Rees model, if we assume that the production function exhibits constant returns to scale then the value of household production at the imputed price, py, will equal the total cost of production $\Sigma w_i t_i$, and so we can write the household full income budget constraint as

$$\Sigma(x_i + py_i + w_i z_i) = \Sigma T w_i + M = Y \qquad (7)$$

giving full income shares, in the example taken here:

$$s_f = (x^* + py_f + w_f(T - t_f))/Y; \quad s_m = (x^* + py_m + w_m(T - l_m - t_m))/Y \qquad (8)$$

Thus if f spends a large amount of time in domestic production, m relatively little, and m's consumption of the domestic good is high relative to f's, then the full income shares in (8) could be very different to those in (6). Moreover, the implied interpretation of household economic activity now changes fundamentally. Instead of a transfer, we have exchange based upon a division of labor between household and market production. Now, f may produce y in excess of her own consumption and trade with m for the market good. This interpretation is both a less disparaging and more interesting economic interpretation of f's role in the economy, as well as being, we would argue, more true to life.

Clearly the Apps-Rees model has greater data requirements than does Chiappori's model, and therefore presents greater difficulties for empirical application. Fortunately, these difficulties are not insurmountable. Data are often gathered on individual time allocations to household work, though in the past economists have made surprisingly little use of them. Such data are precisely what we require for measurement of $t_i$ variables in this model. Clearly, given observations on the market labor supply functions $l^i(w_f, w_m, M)$), and household labor supply functions $t^i(w_f,w_m,M)$ it is possible to identify pure leisure demand. With data only on total household expenditure on consumption of the market good (given by total wage plus non-wage income) and imputed expenditure on the domestic good (given by the value of time spent in domestic production at market wage rates) we are, as in Chiappori's model, unable to identify a unique sharing rule. We hope however that the following sections of this paper will show that meaningful econometric estimation can be undertaken and some interesting conclusions drawn.

Specifically, we show that with data on market wages, non-wage incomes, demographic variables, labor market supplies and time allocations to domestic work, it is possible to estimate a version of the Apps-Rees model. For the purpose of illustrating the limitations of the approach which excludes household production we estimate our model assuming there is no lump sum redistribution of income within the household.[2] We employ time use survey data on hours spent on household production, defined as activities broadly viewed as "housework", to estimate the production side of the model and to derive an implicit price of the domestic good. Since we do not have data on individual market and domestic consumptions we estimate a joint demand for the domestic good and then derive 'actual' individual demands by assigning the residual to spouses to equate fixed effects specified in the demand system. Using this approach we compute the net value of domestic goods traded for market goods within each household. In a model without household production the result would be interpreted as an altruistic lump sum transfer to the spouse who is in fact trading domestic goods for money income to buy market goods. To demonstrate this point, we go on to estimate such a model using the estimated values of trade as data for lump sum transfers. Since wives typically specialize in domestic production, the model yields results indicating that they are the recipients of large transfers from their husbands and that they have much larger consumptions of leisure. This shows that for purposes of empirically-based discussion of the consequences of policy changes it is important to adopt the correct modeling approach.

## 3 Empirical Specification

The Apps-Rees household model has both a production side and a consumption side, the link between them being the imputed price of the domestic good, p, which is equal to its marginal cost, c. We model the production side by assuming first that the household production function exhibits constant returns to scale, As is well-known, the total cost function can be written as

$$C = c(w_f, w_m)y \qquad (9)$$

and

$$t_i = (\partial c/\partial w_i)y \qquad i = f,m \qquad (10)$$

We next assume that the cost function is translog, implying that

$$t_i = (c/w_i)(a_i(d^i, \mu^i) + a_{ii}\ln w_i + a_{ij}\ln w_j)y \quad , \; i,j = f,m, \; i = j \qquad (11)$$

where $a_i$ and $a_{ij}$, $i,j = m,f$ are parameters, $d^i$ is a vector of demographic characteristics which can be assumed to affect costs at given wage rates, and $\mu^i$ is an error term that allows random variation in production coefficients across households. Since $p = c$, and the constant returns to scale assumption implies that $py = \Sigma w_i t_i$, we have for estimation the share equations

$$(w_i t_i/\Sigma w_i t_i) = a_i(d^i, \mu^i) + a_{ii}\ln w_i + a_{ij}\ln w_j \qquad i,j = f,m, \; i = j \qquad (12)$$

Since we have data on all variables in (12) we can estimate the cost function parameters.

Demographics are entered as

$$a_i(d^i, \mu^i) = a_i^0 + a_i^1 D^1 + a_i^2 D^2 + a_i^3 \ln N + a_i^4 \ln A^f + a_i^5 \ln A^m + \mu^i \qquad (13)$$

where $D^1$ and $D^2$ are dummy variables for age of youngest child in the categories 0-4 and 5-9 years, N is number of dependent children, $A^f$ is wife's age and $A^m$ is husband's age.

The price of the domestic good can be computed as the exponent of the unit cost function, that is, as

$$p = c = \exp(a_0 + \Sigma a_i(d^i, \mu^i)\ln w_i + 0.5\Sigma\Sigma a_{ij}\ln w_i \ln w_j) \qquad i = f,m \qquad (14)$$

On the consumption side we estimate the Deaton and Muellbauer (1980) 'Almost Ideal Demand System' specification of preferences. The indirect utility function for individual i takes the form

$$V^i(w_i, p, Y_i; s^i, e^i) = \ln(Y_i/A^i(w_i,p; s^i, e^i)/B^i(w_i, p) \qquad i = f,m \qquad (15)$$

where the price indexes $A^i(.)$ and $B^i(.)$ are given by

$$\ln A^i(w_i, p; s^i, e^i) = \alpha_0 + \alpha_z^i(s_z^i, e_z^i)\ln w_i + \alpha_y^i(s_y^i, e_y^i)\ln p + 0.5\gamma_{zz}\ln w_i + 0.5\gamma_{yy}\ln^2 p + \gamma_{zy}\ln w_i \ln p \qquad (16a)$$

$$B^i(w_i, p) = w_i^{\beta_z} p^{\beta_y} \qquad (16b)$$

and $\alpha_0, \alpha_z^i, \alpha_y^i, \gamma_{zz}, \gamma_{yy}, \gamma_{zy}, \beta_z$ and $\beta_y$ are parameters, $s_k^i$ is a dummy variable for gender, taking the value of one for females and zero for males, and $e_k^i$ is the stochastic component of preferences, i = f,m, and k = z,y,x. The variable $Y_i$ is i's full income <u>net of intra-household transfers</u>, and so is determined by the household sharing rule.

Individual demands in share form are

$$S_z^i = \alpha_z^i(s_z^i, e_z^i) + \gamma_{zz}\ln w_i + \gamma_{zy}\ln p + \beta_z\ln(Y_i/A^i(w_i, p; s_z^i, e_z^i)) \qquad (17a)$$

$$S_y^i = \alpha_y^i(s_y^i, e_y^i) + \gamma_{yz}\ln w_i + \gamma_{yy}\ln p + \beta_y\ln(Y_i/A^i(w_i, p; s_y^i, e_y^i)) \qquad (17b)$$

$$S_x^i = \alpha^i(s_x^i, e_x^i) + \gamma_{xz}\ln w_i + \gamma_{xy}\ln p + \beta_x\ln(Y_i/A^i(w_i, p; s_x^i, e_x^i)) \qquad (17c)$$

i = f,m, and where $S_z^i = w_i z_i/Y_i$, $S_y^i = py_i/Y_i$ and $S_x^i = x_i/Y_i$. Adding up restrictions imply $\Sigma\alpha_k = 1$, $\Sigma\gamma_{kj} = 0$ and $\Sigma\beta_k = 0$, for k,j = z,y,x. In addition we require: homogeneity, $\Sigma\gamma_{jk} = 0$; symmetry, $\gamma_{kj} = \gamma_{jk}$; and concavity of the expenditure function which is satisfied if the Slutsky matrix is negative semidefinite.

The leisure share intercept coefficient incorporating preference variation by gender is specified as

$$\alpha_k^i(s_k^i, e_k^i) = \alpha_k^0 + \alpha_k^1 s^i + e_k^i \tag{18}$$

for k = z,y,x.

In order to estimate the individual share equations and thus retrieve exact individual utility functions we would need data on individual consumption shares $S_k^i$, k = x,y, and the individual net-of-transfer full incomes, $Y_i$. Since we do not have individual consumption share data we work with joint consumption shares $S_k^f + S_k^m = S_k$, k = x,y. It is straightforward to compute the full incomes $w_iT + m_i$ for each individual, and setting $Y_i$ at these values in effect assumes that there are no intra-household lump sum transfer, which is of course one special case of a sharing rule. We do this as a basis for the estimation of Model 1.

Suppose that Model 1 is actually the true model , so that the data we observe are generated by it. We can use the model to generate individual consumptions of the market good. Now suppose these data on the individual consumptions of the market good and the individual market labor supplies were observed by someone wishing to estimate Chiappori's model. For any household, if, say, $x_f - (w_f l_f + m_f) = \tau_f > 0$, then f must be regarded as the recipient of a transfer $\tau_f$ and we set $Y_f = w_f t + m_f + \tau_f$ and $Y_m = w_m T + m_m - \tau_f$. Given these $Y_i$ values we can estimate the model (ignoring of course the production side) and these results are given as Model 2 below. In effect, in Model 2 the income that f gains from trading the domestic good is being treated as a lump sum transfer. We now go on to compare the models' results.

## 4 Empirical Results of the Models

The analysis is based on data for a sample of 1447 employed families selected from the ABS 1985/6 Income Distribution Survey Sample file. Information on hours spent on work at home is drawn from the 1987 ABS Time Use Pilot Survey file (see ABS, 1988) and merged with the data for families from the 1985/6 file, using regression analysis. Consumption demands, time allocations and results for intra-household trade, equivalent incomes and the price of the domestic good are reported for the 1447 family records in the 'full sample' and for two subsamples representing 'traditional' families, selected as those with a wife working less than 500 hours in the market place (861 records), and 'non-traditional' families, defined as those with a wife employed for 500 hours or more p.a. (586 records). Detailed information on data sources and sample selection criteria is given in Appendix A. The means of the data for the full sample and for the traditional and non traditional subsamples are listed in Table 1B of Appendix B.

The systems are estimated on data for a subsample of 551 families in which the wife is employed for 500 hours or more and has net hourly earnings greater than $3.00 and less than $20.00. The results for the maximum likelihood estimation of the parameters of the household production and demand system, assuming no lump sum transfers between family members, are presented in Table 1 under Model 1. The parameters of the system omitting household production and treating the value of trade computed from Model 1 as a transfer are reported under Model 2. The upper half of the table lists the parameters of the production side of Model 1 estimated subject to the following restrictions: $\Sigma a_i(d^i, \mu^i) = 1$; $\Sigma\Sigma a_{ij} = 0$; and $a_{ij} = a_{ji}$; for i,j = m,f. The intercept term $a_0$ in the unit cost function is set to zero. The lower half of the table gives the parameters of the demand systems. Since each system is constrained to satisfy the adding up restrictions, the market good share equation can be omitted for estimation. As noted earlier, domestic goods shares are estimated as a joint equation. Annual leisure hours are obtained by subtracting total annual hours of work (both in the market and in the household)

**Table 1 Parameter Estimates**

| | Model 1 | | Model 2 | |
|---|---|---|---|---|
| Parameter | Estimate | (std.err) | Estimate | (Std.err) |
| Production system | | | | |
| $a^0_f$ ($D^1$) | 0.8112 | (0.0935) | - | - |
| $a^1_f$ ($D^2$) | 0.0107 | (0.0116) | - | - |
| $a^2_f$ (lnN) | -0.0222 | (0.0101) | - | - |
| $a^3_f$ (lnF) | 0.0059 | (0.0088) | - | - |
| $a^4_f$ (lnM) | 0.0152 | (0.0305) | - | - |
| $a^5_f$ | -0.0542 | (0.0276) | - | - |
| $a^6_f$ | 0.2414 | (0.0095) | - | - |
| Demand system | | | | |
| $\alpha^0_z$ | 0.4244 | (0.0134) | 0.5014 | (0.0077) |
| $\alpha^1_z$ (s) | -0.0301 | (0.0132) | 0.0567 | (0.0021) |
| $\alpha^0_v$ | 0.1038 | (0.0169) | - | - |
| $\alpha^1_v$ (s) | 0.0409 | (0.0267) | - | - |
| $\gamma^4_{zz}$ | 0.2135 | (0.0106) | 0.1391 | (0.0057) |
| $\gamma^0_{vv}$ | 0.1755 | (0.0186) | - | - |
| $\gamma^0_{zv}$ | -0.1086 | (0.0137) | - | - |
| $\beta^0_z$ | -0.4981 | (0.0214) | -0.6085 | (0.0057) |
| $\beta^0_v$ | -0.1450 | (0.0255) | - | - |
| Log L | 3025.20 | | 1420.40 | |
| Number of records | | 551 | | |

from time available, T, which is set to 5840 hours (16 hours per day for 365 days). The intercept term, $\alpha_0$, is set to 9.0. Net wage rates and virtual incomes are calculated by applying the 1985/6 marginal tax rate schedule and rebates to reported incomes.

On the production side of Model 1 the demographic variables for age of youngest child in the 5-9 category and log of husband's age are significant at the 95 per cent level. The negative coefficients suggest that the time allocated to household production by the female member of the household declines when the youngest child enters the 5-9 year age group and as husband's age increases. The intercept and own and cross wage coefficients are significant at well above the 95 per cent level. On the demand side of Model 1 all variables are significant with the exception of the dummy variable for gender in the household good share equation. In the case of Model 2, all variables are significant at well above the 95 per cent level. There are interesting differences between the coefficients of the two models. In particular, the coefficient on the dummy variable for gender in the leisure share intercept is negative in Model 1 but positive in Model 2. The negative coefficient in Model 1 reflects the fewer hours of leisure of the female member of the household when hours of housework are subtracted from her non-market time. In contrast, because housework is treated as leisure in Model 2, the estimated coefficient suggests that the female member has more leisure. The coefficient is also relatively large, with a higher level of significance than in Model 1, indicating that preference variation by gender is much more important in Model 2.

We now compare the consumption demands of family members, their work-leisure choices, and the intra-family distribution income and consumption implied by the systems. Table 2 reports the means of these variables for Model 1. The first two columns present results for the full sample. Columns 3 and 4 give separate figures for the subsample of households in which the wife is employed for less than 500 hours p.a., and Columns 5 and 6 for those in which the wife is employed for 500 hours or more p.a. Rows 1 to 3 show mean female and male expenditures p.a. on the three goods - leisure, the domestic good and the market good, with 'actual' demands for the domestic and market goods computed for $e_y^f = e_y^m$. Rows 4 to 6 give mean female and male hours of leisure, market work and domestic work p.a., respectively. The value of market goods traded for domestic output is shown in Row 7. Mean full income is reported in Row 8. Equivalent income, calculated as the income required to achieve the utility level at a reference wage rate, domestic good's price and gender, and at reference error terms, is reported in Row 9. The mean price of the domestic good is shown in Row 10. Table 3 presents results for Model 2

**Table 2 Model 1**

| | Variable means | Full sample Female 1 | Full sample Male 2 | Fem emp<500hpa Female 3 | Fem emp<500hpa Male 4 | Fem emp≥500hpa Female 5 | Fem emp≥500hpa Male 6 |
|---|---|---|---|---|---|---|---|
| 1 | Leisure exp $p.a. | 20173 | 19169 | 22479 | 19682 | 16784 | 18417 |
| 2 | Domestic good exp $p.a. | 11852 | 9632 | 13987 | 11479 | 8715 | 6918 |
| 3 | Market good exp $p.a. | 10980 | 14148 | 9421 | 12204 | 13271 | 17003 |
| 4 | Hours of leisure p.a. | 2886 | 2967 | 2991 | 3029 | 2733 | 2876 |
| 5 | Hours of market work p.a. | 593 | 2178 | 43 | 2165 | 1402 | 2200 |
| 6 | Hours of domestic work p.a. | 2361 | 695 | 2806 | 646 | 1705 | 764 |
| 7 | Intra-household trade $p.a. | 5085 | 5085 | 7208 | 7208 | 1967 | 1967 |
| 8 | Full income $p.a. | 43006 | 42950 | 45888 | 43366 | 38771 | 42338 |
| 9 | Equivalent income $p.a. | 43403 | 52020 | 40092 | 47093 | 48267 | 59258 |
| 10 | Price of domestic good $ | 6.87 | 6.87 | 7.30 | 7.30 | 6.23 | 6.23 |

**Table 3 Model 2**

| | Variable means | Full sample Female 1 | Full sample Male 2 | Fem emp<500hpa Female 3 | Fem emp<500hpa Male 4 | Fem emp≥500hpa Female 5 | Fem emp≥500hpa Male 6 |
|---|---|---|---|---|---|---|---|
| 1 | Leisure exp $p.a. | 37111 | 23716 | 43675 | 23953 | 27466 | 23368 |
| 2 | Domestic good exp $p.a. | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | Market good exp $p.a. | 10980 | 14148 | 9421 | 12205 | 13271 | 17003 |
| 4 | Hours of leisure p.a. | 5247 | 3662 | 5797 | 3675 | 4438 | 3640 |
| 5 | Hours of market work p.a. | 593 | 2178 | 43 | 2165 | 1402 | 2200 |
| 6 | Hours of domestic work p.a. | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | Intra-household transfer $p.a. | 5085 | -5085 | 7208 | -7208 | 1967 | -1967 |
| 8 | Full income $p.a. | 48091 | 37865 | 53096 | 36158 | 40737 | 40371 |
| 9 | Equivalent income $p.a. | 48726 | 50969 | 47710 | 44792 | 50988 | 58470 |

in the same format, with the exception of Row 7 which reports the value of trade as a lump sum transfer, and the omission of Row 10.

Row 7 illustrates the role of household production in determining the 'sharing rule' and leisure demands. In Model 1, the female member of the household specializes in domestic production and, on average, earns $5085 from trading domestic output. The trade does not alter the full incomes of family members. In contrast, according to Model 2, the husband's net expenditure on domestic output is a lump sum transfer to the wife. The 'sharing rule' induces husbands to make an altruistic lump sum transfer to wives of an average amount of $5085 p.a. As a result the mean full income of wives rises from $43006 to $48091 p.a. and that of husbands falls from $42950 to $37865. Female and male hours of work and leisure reported for Model 1 indicate similar demands for leisure, with husbands enjoying slightly longer hours than wives. In contrast Model 2 suggests large differences in leisure demands, with a mean of 5247 hours for wives and of 3662 hours for husbands.

If we compare the results for families with the more traditional division of labor (wife working for less than 500 p.a.) and for those with two earners (wife employed for 500 hours or more p.a.) we find that the mean value of trade is much larger for the former group, $7208 and $1967 respectively. Because Model 2 ignores domestic production, wives in traditional households are inevitably found to be beneficiaries of substantial lump sum transfers from their husbands, as indicated by these figures. And they are also found to have more extreme demands for leisure.

The equivalent incomes generated by the models reflect assumptions concerning the productivity and price of non-market time. As in market activity, some individuals may be more productive than others in their use of non-market time, and so households with the same female and male time allocations to housework and leisure may have different outputs from both types of activity. The standard labor supply model, in addition to ignoring the production of tradeable goods at home, assumes implicitly that the productivity of non-market time is identical within and across households. The model arbitrarily defines the output of non-market time as 'leisure', a homogeneous commodity with a price varying with the net wage. There is however no justification for this kind of data construction. As shown in Apps (1991), treating non-market time in this way can be expected to yield equivalent income orderings of individuals and of families which are negatively correlated with hours of non-market time, because the latter will be the higher priced 'good' if the ratio of the wage to price of the market good is greater than one.

In our analysis we have departed from the standard model by treating female and male time inputs to domestic production as two types of labor. Since our focus is on intra-family issues, we do not attempt to introduce productivity differences across households. We also treat leisure activities in the conventional way. As expected, the direction of differentials between the mean equivalent incomes and mean full incomes of females and males in the two types of households reflect the data construction. The mean equivalent income of wives working less than 500 hours generated by both models is less than their mean full income. In the case of wives working 500 hours or more, mean equivalent income is greater than mean full income. Similarly, because husbands typically work longer market hours than wives, their equivalent incomes tend to be greater than their full incomes. Results of this kind can be reversed by treating non-market time in the same way as market time (see Apps (1991)).

Welfare comparisons based upon equivalent incomes can be made only if it makes sense to assume identical preferences. Clearly the traditional and non-traditional households we have considered cannot be assumed to have identical preferences, due to the underlying data construction and the variation in demands for the market and domestic goods. It also makes no sense to assume members of a given household have identical preferences when we employ a collective approach based on a conventional labor supply model, as in Model 2. Model 1 however suggests that female and male family members have similar demands and so the results of a system imposing identical male and female preferences are likely to be more representative.[3] This is illustrated by Table 4. The table reports mean demands for leisure, the domestic good and the market good, and for equivalent incomes, assuming identical female and male preferences.

**Table 4 Model 1 - Identical Female and Male Preferences**

| | Variable means | Full sample | | Fem emp<500hpa | | Fem emp≥500hpa | |
|---|---|---|---|---|---|---|---|
| | | Female | Male | Female | Male | Female | Male |
| | | 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | Leisure exp $p.a. | 19995 | 18882 | 21940 | 19668 | 17138 | 17727 |
| 2 | Domestic good exp $p.a. | 10720 | 10484 | 12676 | 12362 | 7846 | 7725 |
| 3 | Market good exp $p.a. | 11780 | 13583 | 10427 | 11336 | 13768 | 16886 |
| 4 | Hours of leisure p.a. | 2910 | 2937 | 2978 | 3039 | 2809 | 2786 |
| 9 | Equivalent income $p.a. | 44880 | 51005 | 41897 | 45122 | 49263 | 59650 |

Comparing leisure and consumption demands across Tables 2 and 4 we find the figures are relatively similar. As we would expect, the hours of leisure of the group working the longest hours, wives in two earner families, increase slightly while those of the groups working the fewest hours, females and males in more traditional families, tend to fall. Consistent with Table 2, mean equivalent incomes in Table 4 suggest that the female member of the family is less well off than the male member in both types of households. No comparisons can be made between household types for the reasons already indicated.

## 5 Conclusions

The basis of the "collective" labor supply approach is the modeling of the household as a collection of individuals. An important consequence of this approach is the possibility it creates of analyzing the intra-household distribution of income, consumption and welfare. This paper has argued, and we hope demonstrated empirically, that it is of central importance to incorporate the analysis of household production, owed to Becker (1965), if we are to avoid both misleading theoretical results and empirical misspecification. We also hope to have carried the approach a step further by showing how an empirical model can be specified and estimated. An important factor in making this step was the availability of data on individual time inputs to domestic production involving 'housework' activities.

A major limitation of the empirical analysis arises out of the current unavailability of data on consumptions of individual household members. This does not seem to us to be an insuperable obstacle, since it could be collected in the same way that the data on individual time inputs to household activities are compiled. Moreover it is likely that we would find that a large proportion of expenditure is on goods that are consumed jointly, such as housing, heat, light, consumer durable services and so on. The range of goods whose consumption differs significantly across individuals in the household may be relatively small. Indeed, it may be that the most important difference lies in consumption of (pure) leisure, in which case it is even more important to ensure that leisure is not confused with time spent in domestic production in the formulation of models of the household.

**Notes**

1 The approach is a generalization of earlier work by Manser and Brown (1980), McElroy and Horney (1981), Apps (1982) and others, which departed from tradition by modeling explicitly the role of the individual in the household decision process. For a survey of the development and application of the traditional household model, see Killingsworth (1983).

2 The specification of the system is consistent with the model in Apps (1982) and Apps and Jones (1986).

3 The analysis does of course raise the issue of gender heterogeneity in preferences for different types of jobs (market versus domestic) which has been examined in the context of market jobs by Killingsworth (1987).

## Appendix A: Data sources and sample selection criteria

The study employs data for a sample of families drawn from the ABS 1985/6 Income Distribution Survey Sample file. The file contains 10815 income unit records in complete households. An income unit is defined to contain either one non-dependent 'head' or two non-dependent persons forming a couple with the male partner classified as 'head' and the female partner as 'spouse'. Dependents are defined as unmarried persons living with their parent(s) and either 15 years of age or full-time students aged 15 to 20 years. A total of 4522 records represent couple income units. The sample for the study comprises 1447 families selected from couple income units on the following criteria:

1. Head and spouse (if employed) earning labor income only (excludes couples with earnings from partnerships, own business or farms). No. of records: 3795.
2. Head aged 20 to 64 years. No. of records: 3240.
3. Dependents under 15 years. No. of records: 1647.
4. Head working 500 hours or more p.a., with a gross wage exceeding $3.00. No. of records: 1483.
5. Head and spouse with consistent hours and earnings data. No. of records: 1447.

For each family the ABS 1985/86 file provides information on demographic and personal characteristics, and on hours of market work, earnings and the non- labor income of each spouse. The measure of the gross wage used for participants is gross hourly earnings, calculated from market hours and earnings. Wage rates for wives who are non-participants are constructed from a female wage equation estimated on data for a sample of 586 wives employed for 500 hours or more annually. In the estimation of the wage equation the Heckman procedure is applied to correct for sample selection bias, explaining whether a wife works 500 hours or more in terms of specified market and reservation wage variables. The lower bound of 500 hours is chosen in order to reduce measurement error in gross hourly earnings arising from limitations of the data for those working fewer hours.

Information on hours of housework is drawn from the 1987 ABS Time Use Pilot Survey file (see ABS, 1988) and merged with the data for families from the ABS 1985/6 file, using regression analysis. The 1987 ABS file contains records for 1611 persons (respondents) and activity episodes (up to 72 records per diary day, depending on the number of activities reported). The person records include data on demographic and personal characteristics, income and hours of market work. Because the income data does not separate non-labor income from earnings, it is not possible to calculate an hourly earnings variable as a measure of the gross wage. For this reason the study employs the data set for families from the ABS 1985/6 file. Separate regression equations are estimated for males and females on data for a sample of 211 couples with dependents under 15 years selected from the ABS 1987 file.

The activity records in the 1987 ABS file report time allocations to labor force activities and to household activities including housework, education and active and passive leisure activities. Hours of housework are calculated as the sum of hours allocated to the housework activities in the following categories:

i) Domestic activities:
   Housework - food and drink preparation, clean-up; Laundry, ironing and clothes care: Other housework.
   Other domestic activities - Gardening, lawn care and pool care; Pet/animal care; Home maintenance, improvement and care; Household paperwork, bills, etc.; Providing transport for other household members.

ii) Child care/minding:
   Own children - Physical care and minding; Care for sick or disabled; Teaching, helping, reprimanding; Playing, reading to, talking to.
   Other children - Physical care and minding; Care for sick or disabled; Teaching, helping, reprimanding; Playing, reading to, talking to. Associated travel.

iii) Purchasing goods and services: Goods; Services; Associated travel.

Due to data limitations, ad hoc female and male hours of housework equations are estimated as linear functions of variables for which information is available in both data files. The results are available from authors.

**Appendix B: Table B1 Means of Data** (standard deviations in parentheses)

| Variable | Full sample | Wife emp<500h | Wife emp>500h |
|---|---|---|---|
| Female | | | |
| Gross wage$ | - | - | 8.32 |
| | | | (2.97) |
| Non-labour income$p.a. | 1344 | 1355 | 1328 |
| | (2456) | (2279) | (2697) |
| Hours of market work p.a. | 593 | 43 | 1402 |
| | (763) | (107) | (569) |
| Hours of housework p.a. | 2361 | 2806 | 1705 |
| | (690) | (370) | (504) |
| Age | 33.2 | 32.5 | 34.3 |
| | (6.3) | (6.3) | (6.2) |
| Male | | | |
| Gross wage$ | 11.48 | 11.55 | 11.33 |
| | (4.09) | (4.00) | (4.99) |
| Non-labor income$p.a. | 1123 | 781 | 1624 |
| | (6099) | (3124) | (8785) |
| Hours of market work p.a. | 2179 | 2165 | 2200 |
| | (360) | (378) | (330) |
| Hours of housework p.a. | 695 | 646 | 764 |
| | (202) | (199) | (187) |
| Age | 36.1 | 35.3 | 37.1 |
| | (7.1) | (6.8) | (7.3) |
| Family | | | |
| Children aged 0-4 years | 0.75 | 0.92 | 0.49 |
| | (0.79) | (0.82) | (0.65) |
| Children aged 5-9 years | 0.68 | 0.73 | 0.61 |
| | (0.80) | (0.83) | (0.75) |
| Children aged 10-14 years | 0.36 | 0.31 | 0.42 |
| | (0.56) | (0.54) | (0.59) |
| Household size | 4.01 | 4.14 | 3.82 |
| | (0.91) | (0.95) | (0.80) |
| Number of records | 1447 | 861 | 586 |

**References**

A.B.S. (1988), Information Paper: Time Use Pilot Survey, Sydney, May-June 1987, Cat.No. 4113.1

Apps. P.F.(1991), Labour Supply and Welfare: Some Effects of Neglecting Housework and Intra-Family Inequality, Working Paper No. 240, Working Papers in Economics and Econometrics, Research School of Social Sciences, Australian National University, Canberra. (Forthcoming in R.Blundell, I.Preston and I.Walker (eds), The Measurement of Household Welfare, Cambridge University Press.)

Apps, P.F. (1982), "Institutional Inequality and Tax Incidence", Journal of Public Economics, 18, 217-42.

Apps, P.F. and G.S.Jones (1986), "Selective Taxation of Couples". Zeitschrift fur Nationalokonomie, Suppl.5, 63-74.

Apps, P.F. and R.Rees (1988), "Taxation and the Household", Journal of Public Economics, 35, 155-169.

Becker, G.S. (1965), "A Theory of the Allocation of Time", Economic Journal, 75, 493-517.

Chiappori, P.A. (1992), "Collective Labor Supply", Journal of Political Economy, 100, 437-467.

Chiappori, P.A. (1988), "Rational Household Labor Supply", Econometrica, 56, 64-89.

Deaton, A. and J.Muellbauer (1980), "An Almost Ideal Demand System", American Economics Review, 70, 312-326.

Killingsworth, M. (1983), Labor Supply, Cambridge University Press, Cambridge.

Killingsworth, M. (1987), "Heterogeneous Preferences, Compensating Wage Differentials, and Comparable Worth", The Quarterly Journal of Economics, 102, 727-741.

Manser, M. and M.Brown (1980), "Marriage and Household Decision Making: a Bargaining Analysis", International Economic Review, 21, 31-44.

McElroy, B. and M.J.Horney (1981), "Nash-Bargained Household Decisions: Towards a Generalization of the Theory of Demand", International Economic Review, 22, 333-350.