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Identifying Intra-Household Welfare Distribution

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Abstract

The paper proposes a new application of the collective model of household behaviour to the analysis of intra-household inequality using the answers to the questions on subjective welfare.

The collective approach attributes to each household member distinct preferences and assumes that household decisions are Pareto efficient. The individual choices are guided by the sharing rule describing the intra-household decision making. So far, most empirical studies based on the collective approach have been restricted to the identification of the sharing rule up to a constant.

This study extends the work of Kalugina, Radtchenko, Sofer (2009) and proposes a new method of the sharing rule identification using the information on individual welfare satisfaction as an additional source of analysis. In spite of different sources of identification used in the two analyses and substantial differences of the econometric models adopted according to the identification sources, the results of the sharing rule estimation are qualitatively and quantitatively similar to those obtained in Kalugina, Radtchenko, Sofer (2009).

Key words: Collective model, Sharing rule, Within-household Inequality, Subjective data

JEL Classification: D1, J22, D63, C5.

Introduction

One important application afforded by the collective model proposed by Chiappori (1992, 1998) concerns intra-household welfare analysis. Because each household member is assumed to have distinct preferences, a Pareto efficient solution can be obtained by maximising the weighted sum of the utility functions. The weights can be interpreted as indicators of the bargaining power distribution within the household.

Most empirical studies based on the collective approach have been limited by the fact that the the sharing rule can only be identified up to a constant. This restriction is due to the unavailability of data on individual consumption. [1] Kalugina, Radtchenko, Sofer (2009) extend Chiappori's results by showing how the entire sharing rule can be identified. Their method is based on the use of subjective income data and interpreting intra-household equality as equal sharing of household full-income.

This paper proposes a novel approach to the full identification of the sharing rule. As in Kalugina, Radtchenko and Sofer (2009), we use subjective data but interpret intra-household equality as equality of utility rather than income. Consequently, the full identification of the sharing rule rests on a entirely different method. The key is in using households reporting the same level of satisfaction. Equality of satisfaction imposes an additional behavioural constraint that needs to be taken into account. The advantage of the method based on the satisfaction question is that its interpretation is more straightforward and its use does not involve measuring individual budget shares, thus avoiding potential measurement errors.

Because the two approaches are based on different identification strategies, the econometric models differ substantially. Yet, the parameter estimates of the sharing rule are qualitatively and quantitatively similar to those obtained in Kalugina, Radtchenko, Sofer (2009). The single main difference relates to the impact of pre-schoolers on the bargaining power of the spouses. Otherwise,

⋆ I am grateful to Catherine Sofer for helpful comments.
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[1] Labour supply information only allows the identification up to a constant (Chiappori (1992, 1998))

the results of the sharing rule estimation support the robustness of the general strategy of using subjective data as an additional source of information.

We first show how the sharing rule can be fully identified assuming equality of utility. We also provide an empirical illustration of this result. The data are drawn from the *Russia Longitudinal Monitoring Survey* (RLMS). Kalugina, Radtchenko, Sofer (2007a, 2007b) provide various tests based on the RLMS subjective data and show that differences in subjective answers reflect true differences in welfare sharing.

The paper is organised as follows: Section 1 presents the collective model. Section 2 presents the data. Section 3 develops the identification strategy of the sharing rule. Finally, Section 4 presents the results.

1 Model

The theoretical framework used in this study is that of the collective model with household production (Apps and Rees (1997), Chiappori (1997), Rapoport, Sofer and Solaz (2003, 2006)). In this model, total labor supply is defined as market and domestic time allocation. The identification of the sharing rule is based on total labor supply which is usually more accurately estimated than when based on market labour alone (Chiappori, Fortin, Lacroix (2002), Clark, Couprie et Sofer (2004)).

1.1 Collective Model with Household Production

Consider two individuals $i = f, m$. Each has a utility function that depends upon leisure (assignable and observed), L_i, the consumption of a Hicksian composite good (unobserved), C_i, with a normalized price of 1, and a vector of domestic goods $\mathbf{Y}$: $U_i = U_i(L_i, C_i, \mathbf{Y}_i; \mathbf{z})$, where $\mathbf{z}$ is a vector representing household heterogeneity.

The basic optimisation problem of the collective model with household production can be decomposed into three stages (Apps, Rees (1997) and Chiappori (1997)): first, the household determines the optimal allocation of time of each

member in domestic production by maximizing the profit or net value of domestic production. [2] This imputed profit is added to the other income flows. In the second stage, the sharing rules is defined depending on individual preferences and bargaining power; finally, given the appropriate choice of individual shares of the total household, individual allocations are defined by solving individual utility maximisation problems.

Thus the household maximisation problem can be formulated as following:

$$\underset{t_f,t_m}{Max}\,\Pi = \mathbf{pY} - w_f t_f - w_m t_m \tag{1}$$

$$\underset{C_i,L_i,Y_i}{Max}\; U_i(L_i, C_i, \mathbf{Y}_i; \mathbf{z}), \mathrm{i} = f, m \tag{2}$$

Subject to budget and time constraints:

$$C_i + \mathbf{pY}_i + L_i w_i \leq \Phi_i \tag{3}$$

$$L_i + h_i + t_i = T \tag{4}$$

where t_i is member i's time allocation to the household production; h_i is his/her time allocation to the market work; T is the total available time; w_f and w_m are female and male wage rates, respectively; $\mathbf{p}$ is the price vector of the domestic goods. The sharing rule $\Phi_i(w_f, w_m, \mathbf{p}, y; \mathbf{s}, \mathbf{z})$ depends on the distribution factors vector $\mathbf{s}$. [3] It determines the individual shares of the total household income allocated to each household member i:

$$\Phi = \Phi_f + \Phi_m = (w_m + w_f)T + y + \Pi, \tag{5}$$

[2] As neither market goods inputs nor the output of household production are observable, the assumption that only time inputs enter the household production function is the only one empirically tractable. Thus we follow Apps and Rees (1997) and Chiappori (1997) in introducing the production cost in the same way as in Gronau's (1977) seminal work where it is evaluated at the opportunity cost of time allocated to the household production.

[3] Distribution factors are variables that influence the bargaining power of household members, but neither prices nor preferences, (see Chiappori, Fortin and Lacroix, 2002).

with y represnting household non labour income; $\Pi(w_f, w_m, \mathbf{p})$ stands for the household production profit, *i.e.* the difference between the production value and cost.

The solution to the programme (1)-(5) determines the Marshallian demand functions for leisure for each spouse:

$$L_f = L^f(w_f, \Phi_f(w_f, w_m, y, p, \mathbf{s}, \mathbf{z}); \mathbf{z})$$
$$L_m = L^m(w_m, \Phi - \Phi_f(w_f, w_m, y, p, \mathbf{s}, \mathbf{z}); \mathbf{z})$$

1.2 Intra-household Inequality and Sharing Rule

Intrahousehold inequality can be defined in different ways. Kalugina, Radtchenko, Sofer (2009, 2007a, 2007b) propose two approaches:

(1) The first consists in interpreting reported intra-household equality as **equal sharing** of total household income ($\Phi_f = \Phi_m = \Phi/2$), where the total income is defined in (5) as the sum of monetary and non monetary income.
(2) The second generalizes the first by interpreting intrafamily equality as equal **utility**: $W_f(w_f, \Phi_f) = W_m(w_m, \Phi_m)$, where $W_f = W_f(\cdot)$ and $W_m = W_m(\cdot)$ are female and male indirect utility, respectively. However as we stress below, under mild assumptions, a comparison of "utility" levels in the framework we develop does not involve a strict cardinal representation of the preferences.

Indeed, let the indirect utility function, V_i, be additively separable in its monetary arguments, *i.e.* wage and income, and in its other arguments such as wealth, optimism, past experience and any predisposition to be happy. To fix ideas, let $W_i(w_i, \Phi_i)$ be associated with monetary welfare and $Q_i(\cdot)$ with subjective welfare which depends on non-monetary determinants. More precisely, write:

$$V_i = W_i(w_i, \Phi_i) + Q_i(\cdot), \ i = f, m$$

Assume further that the the domain of the arguments are identical across spouses and that $W_i(w_i, \Phi_i)$ have the same structural parameters, $i = f, m$. It follows that both functions $W_i(w_i, \Phi_i)$ would be defined over the same range. Under these assumptions, equal monetary welfare would lead to the similar values of $W_i(w_i, \Phi_i)$ but would not necessarily imply equality of utility functions V_i.

Obviously, $W_f(w_f, \Phi_i)$ and $W_m(w_m, \Phi_m)$ can never be identical. Even in the unlikely case where $w_f = w_m$ and $\Phi_f = \Phi_m$, monetary welfare may differ because spouses may use different while close scales.

Let I be defined as a latent equality index:

$$I = \begin{cases} 0 & \text{if } W_f(w_f, \Phi_f) < W_m(w_m, \Phi_m) \\ 1 & \text{if } W_f(w_f, \Phi_f) = W_m(w_m, \Phi_m) \\ 2 & \text{if } W_f(w_f, \Phi_f) > W_m(w_m, \Phi_m) \end{cases} \tag{6}$$

Radtchenko(2006) [4] and Kalugina, Radtchenko, Sofer (2007b) use this specification to derive an ordered probit model. Let W^* be a criterion function associated with an unobservable sharing rule determining the difference between $W_m(w_m, \Phi_m)$ and $W_f(w_f, \Phi_f)$:

$$W^* = \gamma' \mathbf{Z} + \varepsilon, \tag{7}$$

where $\mathbf{Z}$ is a vector of household-specific characteristics and distribution factors which are assumed to influence the sharing rule.

Equation (6) can be advantageously estimated by an ordered probit model. Indeed, the probability mass corresponding to $I = 1$ has a continuous dispersion inside of a given interval rather than being concentrated on a single point of exact equality between $W_f = W_m$. It thus allows for some (stochastic) deviations around perfect equality.

Recall that the sharing rule depends on the profit from domestic production Π, which is endogenous as household production depends on the time devoted to

[4] The results can be found on http://pastel.paristech.org/4362/

household work and wage rates. Radtchenko(2006) and Kalugina, Radtchenko, Sofer (2007b) have estimated model (6) along with two equations describing the household work of the two spouses, t_f and t_m:

$$I = \begin{cases} 0 \text{ if } \gamma'\mathbf{Z} + \varepsilon \leq \kappa_2 \\ 1 \text{ if } \kappa_1 < \gamma'\mathbf{Z} + \varepsilon \leq \kappa_2 \\ 2 \text{ if } \gamma'\mathbf{Z} + \varepsilon > \kappa_2 \\ t_f = \alpha_{\mathbf{f}}\mathbf{X_f} + e_1 \\ t_m = \alpha_{\mathbf{m}}\mathbf{X_m} + e_2, \end{cases} \tag{8}$$

where κ_1 and κ_2 are unknown parameters, $\alpha_{\mathbf{i}}$ are the parameter vectors and $\mathbf{X_i}$ are the vectors of individual i specific characteristics and household-specific productivity factors. The error terms ε, e_1 and e_2 are assumed to have a trivariate standard normal distribution with zero mean and variance of ε being 1.

Interestingly, Radtchenko(2006), Kalugina, Radtchenko, Sofer (2007b) find that the correlations between the error terms associated with equality index I and working time devoted to the household production are very low and statistically insignificant. In another paper, Kalugina, Radtchenko, Sofer (2009) argue that the low values found for the correlations imply a negligible surplus from domestic production in comparison to other sources of household income [5]. This is equivalent to assuming that household production is approximately evaluated at its market costs, *i.e.* wages. Following the same argument, the total shared household income is approximated by $\Phi = (w_f + w_m)T + y$ in the empirical part of the paper.

[5] As for households where both members participate in the labor market, Π is the only channel in the theoretical model through which domestic work and the sharing rule could be correlated. The empirical findings support the assumption of the model presented in section 1, and according to which the source of these correlations would be household production profit. Strong correlations would mean that the sharing rule is affected by the time allocated to the domestic work via its profit. Low correlations, on the other hand, could mean that the unobserved characteristics affecting the household (productivity, unobserved inputs...) do not influence the sharing rule much compared with market work characteristics.

2 Subjective Data

As argued in the previous section, the collective model provides a nice framework to analyse intrahousehold inequalities. An issue that arises in empirical applications is how to classify spouses between three groups according to whether they share welfare equally or unequally in favour of the male or the female spouse. Kalugina, Radtchenko, Sofer (2009, 2007a, 2007b) [6] exploit a unique dataset drawn from the Russia Longitudinal Monitoring Survey [7] (RLMS) to tract empirically their concepts of intrahousehold inequality defined either as equal sharing of the total household income ($\Phi_f = \Phi_m = \Phi/2$), or equal utility distribution $W_f(w_f, \Phi_f) = W_m(w_m, \Phi_m)$.

The RLMS is a household-based representative survey of Russia. It is based on two questionnaires administered at the individual and household levels, respectively. In addition to the usual questions, the individual questionnaire contains two questions pertaining to subjective welfare. The first relates to income: "Please imagine a 9-step ladder where on the bottom, the first step, stands the poorest people, and on the highest step, the ninth, stands the rich. On which step are you today?" The second (which is used in the present paper) asks "To what extent are you satisfied with your life in general at the present time?" The possible answers are: "fully satisfied", "rather satisfied", "both yes and no", "less than satisfied", "not at all satisfied" (The descriptive statistics is presented in Table A.2 of appendix A).

The information about subjective well-being is available for each spouse of each household. KRS show that the discrepancies at the household level can be associated with intrahousehold inequality. The validation is based on numerous tests carried out using various inequality indexes derived from the questions pertaining to the subjective income and satisfaction. The basic results are summarized in the following subsection.

[6] KRS in what follows.

[7] All the information on the RLMS data may be found on the project web page: http://www.cpc.unc.edu/rlms.

2.1 Interpretation of the Data

2.1.1 What is the nature of the information provided by the subjective questions presented above?

Radtchenko(2006) and Kalugina, Radtchenko, Sofer(2007b) show that the first question can be interpreted in terms of the individual full income $\Phi_i(w_f, w_m, \mathbf{p}, y; \mathbf{s}, \mathbf{z})$ while the second provides information on the utility, *i.e.* $W_i(w_i, \Phi_i)$.

First of all, they find a positive correlation between the scales of two questions when controlling for demographic variables. Both scales are found to be increasing in wages. This result is consistent with the interpretation: indeed, $W_i(w_i, \Phi_i)$ is an increasing function of Φ_i and both depend on wages of both partners.

The central tests in KRS are the probit-type estimations of model (8) with two types of indexes: using income data and satisfaction data. In each case the index takes three values depending on whether the answers of two partners are the same, or the wife's answer is higher or lower that of her spouse (descriptive statistics are shown in Table A.3 of appendix A: IS takes values 0, 1 or 2 depending on whether the difference observed between female and male satisfaction levels is negative, zero or positive). The main explanatory variable in these estimations is the husband to wife wage ratio: The higher the ratio, the more likely her share of the total revenue or utility welfare is elevated. In the case of the unitary model of household behaviour, the total individual income of each partner is unaffected by the relative wage rates: the discrepancies in self-reported levels would be random and thus not related to the wages. The similarity of the results given by using two different subjective questions can be explained by the common context of economic well-being they are set in. It also shows the close relationship between the information conveyed by the two questions.

Interestingly, in the last available round of RLMS (Round XIII), the same satisfaction question is asked in the section devoted to health. Thus, the individual questionnaire contains the same subjective question in two different sections: one is concentrated on employment, the other is on health. If we look at the answers we find that the correlation between the answers from the

households where both partners work (the sample corresponding to the study of KRS and present paper) is 67%. Thus 33% of individuals have reported different levels of satisfaction with respect to their health and the economic well-being.

Throughout the paper we focus on the economic well-being and argue that the variations in the answers are due basically to the variations in spouses' relative wages and incomes. While attributing the most important impact to economic welfare, we do not constraint however other effects to be zero: indeed, the total individual income Φ_i defined by the collective model presented in Section 1 is close in its nature to the notion of utility as it includes not only monetary income but accounts for leisure consumption as well. In addition, the stochastic terms account for the subjective nature of the information.

2.1.2 Do spouses use similar scales when answering subjective questions ?

First of all, note that the assumption concerns only two individuals living together and sharing thus the same social environment. Therefore, we can assume that they observe the same sets of wages (w_f, w_m) and total incomes (Φ_f, Φ_m). In most empirical papers on labour supply models, $W_i(\cdot)$ is assumed to be identical for all the individuals. The collective labor supply model allows for different specifications for women and men while imposing the same structure for the same gender group. The assumption of close or identical structural parameters $W_f(w_f, \Phi_f)$ and $W_m(w_m, \Phi_m)$ is restrictive in terms of the collective model but is nevertheless more flexible than the assumptions underlying the unitary model. Assuming the same sets of arguments ((w_f and w_m),(Φ_f and Φ_m)) and close structural parameters of $W_f(w_f, \Phi_f)$ and $W_m(w_m, \Phi_m)$ implies the same sets of function values $W_i(w_i, \Phi_i)$. The empirical part of the paper is based on the assumption of similarity of the structural parameters of $W_f(w_f, \Phi_f)$ and $W_m(w_m, \Phi_m)$ when equalizing these functions for spouses giving the same answer on the satisfaction question. This assumption is tested empirically and the data do not reject it.

The present study focuses on rounds V - VIII of RLMS corresponding to the period 1994 - 1998. In addition to the data represented in all RLMS rounds, such as household composition, their living conditions, individual employment information (number of working hours, wage; size, structure and type of enterprise), individual characteristics (sex, age, number of children, and education level), Rounds V–VIII contain time-use data allowing to calculate the number of hours allocated to the home production. Descriptive statistics of the key variables are presented in Table A.1 of appendix A.

The sample used in the econometric analysis below consists of active individuals in the labour force, in which women aged between 16 and 55, and men between 16 and 60. This yields an unbalanced panel of 1480 households with 1914 observations. More than half of the households are observed only once and fewer than 16.8% are observed more than twice. Due to the poor quality of the panel, the estimation of the model rests on a pooling estimator. [8] .

3 Sharing Rule Identification

Suppose a log-linear functional form of labour supply. Such a form is used to ease the econometric modelling as we show below. Besides, it is consistent with the functional form of labour supply found experimentally by Kalugina, Radtchenko, Sofer (2009) using the data on subjective income.

[8] Kalugina, Radtchenko, Sofer (2007b) test for unobserved heterogeneity and find its effect to be negligible. This finding along with observed rather poor quality of the panel, justify the use of pooled data. Lacroix and Radtchenko (2008) provide support for our strategy. Indeed they estimate a collective model using data from 9 rounds of the RLMS corresponding to the period 1994-2004. In addition, they include nonworking individuals. Their results show that the households in this extended sample are relatively homogenous. Because our sample is much more constrained in time and types of households, it is very likely that the households are even more homogenous.

Labor supply H_i $(i = f, m)$ is thus defined as follows:

$$H_i(w_i, \Phi_i) = q_i w_i^{\alpha_i} \Phi_i^{\beta_i}, \tag{9}$$

with individual shares Φ_f and Φ_m summing to the full household income: $\Phi_f + \Phi_m = \Phi = (w_m + w_f)T + y$. [9] The parameters q_i, α_i, β_i need be estimated.

The corresponding economic welfare function is:

$$W(w_i, \Phi_i) = \frac{q_i w_i^{1+\alpha_i}}{1+\alpha_i} + \frac{\Phi_i^{1-\beta_i}}{1-\beta_i}. \tag{10}$$

Based on the discussion of Section 2.1.2, we can assume that two members of the household have similar sets of wages (w_f, w_m), total incomes(Φ_f, Φ_m) and structural parameters q_i, α_i, β_i. Given this assumption, the households whose members report the same level of welfare satisfaction have

$$W_f\left(w_f, \Phi_f\right) = W_m\left(w_m, \Phi_m\right). \tag{11}$$

According to a basic result of the collective model (Chiappori, 1997 and 1988), the sharing rule identification is ascertained up to a constant by examining the labor market behavior of both spouses. The additional information on the welfare satisfaction levels of the household members provides a supplementary constraint (11) allowing the complete identification of the sharing rule. Thus, the behaviour of a household whose members report the same level of welfare satisfaction can be described by the following system of equations:

$$\begin{aligned} \ln H_f &= \alpha_f \ln w_f + \beta_f \ln(\Phi_f) + \ln q_f \\ \ln H_m &= \alpha_m \ln w_m + \beta_m \ln(\Phi_m) + \ln q_m \\ \frac{q_f w_f^{1+\alpha_f}}{1+\alpha_f} + \frac{\Phi_f^{1-\beta_f}}{1-\beta_f} &= \frac{q_m w_m^{1+\alpha_m}}{1+\alpha_m} + \frac{\Phi_m^{1-\beta_m}}{1-\beta_m} \end{aligned} \tag{12}$$

Contrary to the analysis in Kalugina, Radtchenko, Sofer (2009) the individual shares $\Phi_m$and Φ_f are neither observed, nor can be measured. Therefore we need to specify the sharing rule explicitly.

[9] See 1.2 for the discussion on the measurement of the full household income.

The estimation of system (12) requires the definition of the shares Φ_m and Φ_f as well as its logarithms $\ln(\Phi_m)$ and $\ln(\Phi_f)$ while respecting the budgetary constraint and positiveness of the shares. As neither Φ_m nor Φ_f are observed, one variable specification is necessary and sufficient given the only one degree of freedom allowed by the budgetary constraint. Let $\Delta = \Phi_m - \Phi_f$. An appropriate specification is to focus on $d = \Delta/\Phi$. The definition of d allows defining simultaneously the shares with their logarithms while assuming that the shares sum to one. A direct specification of one of the variables such as an individual share (Φ_m or Φ_f) or it's logarithm ($\ln(\Phi_m)$ or $\ln(\Phi_f)$) would not allow to satisfy all the constraints.

Let

$$d = \frac{\Delta}{\Phi} = \frac{\Phi_m - \Phi_f}{\Phi}. \tag{13}$$

The definition (13) jointly with the budgetary constraint gives the system describing the sum and the difference of the shares Φ_m and Φ_f in terms of full income Φ which is observed and d which will be specified by an econometric equation:

$$\begin{cases} \Phi_m - \Phi_f = \Phi_d \\ \Phi_m + \Phi_f = \Phi. \end{cases} \tag{14}$$

Summing up the equations of system (14) gives an expression for the husband's share Φ_m in terms of Φ and d, while subtracting the first equation from the second yields an expression for the wife's share Φ_f :

$$\begin{cases} 2\Phi_m = \Phi_d + \Phi; \\ 2\Phi_f = \Phi - \Phi_d. \end{cases}$$

From the latter the shares are defined as follows:

$$\Phi_m = \frac{\Phi(1+d)}{2} \tag{15}$$

$$\Phi_f = \frac{\Phi(1-d)}{2} \tag{16}$$

Thus in log form

$$\ln(\Phi_m) = \ln(\Phi) + \ln(1+d) - \ln(0.5)$$

$$\ln(\Phi_f) = \ln(\Phi) + \ln(1-d) - \ln(0.5)$$

Because $-\Phi < \Phi_m - \Phi_f < \Phi$, d is restricted to $-1 < d < 1$. In order to satisfy this condition, the equation describing d is specified as an hyperbolic tangent:

$$d = \tanh(Y\theta),$$

where Y is a vector of variables likely to influence the sharing rule (*e.g.* $\ln w_f, \ln w_h$). θ is the vector of corresponding coefficients.

3.2 Statistical Model

Given the specification of the sharing rule presented in 3.1, the model (12) should be completed by introducing the household heterogeneity and stochastic terms. The observed heterogeneity is introduced by allowing q_i to vary with individual and household characteristics **X:**

$$\ln q_i = Q_i + \mathbf{X}_i\gamma_i,$$

where γ_i are the parameter vectors and Q_i are the intercepts.

The unobserved heterogeneity of labor supply is captured by the error terms u_1 and u_2. In addition, an error term u_3 is introduced when defining welfare equality. This term captures some subjective deviations and some possible gaps

in female and male evaluation scales. Finally the statistical model is formulated as

$$\begin{aligned} \ln H_f &= \alpha_f \ln w_f + \beta_f \ln(\Phi_f) + \mathbf{X}_f\gamma_f + Q_f + u_1 \\ \ln H_m &= \alpha_m \ln w_m + \beta_m \ln(\Phi_m) + \mathbf{X}_m\gamma_m + Q_m + u_2 \\ \frac{q_f w_f^{1+\alpha_f}}{1+\alpha_f} &+ \frac{\Phi_f^{1-\beta_f}}{1-\beta_f} - \frac{q_m w_m^{1+\alpha_m}}{1+\alpha_m} + \frac{\Phi_m^{1-\beta_m}}{1-\beta_m} = u_3, \end{aligned} \tag{17}$$

with $\ln q_i = Q_i + \mathbf{X}_i\gamma_i$ and the system error terms assumed to follow a joint trivariate normal distribution.

Since the model is formulated for households whose members report the same answers to the satisfaction question, the error term u_3 corresponds to the truncated error term ε of the model (6). Indeed, the probit model (6) describing inequality index I can be reformulate as

$$I = \begin{cases} 0 & \text{if } W_f(w_f, \Phi_f) - W_m(w_m, \Phi_m) < \kappa_1 \\ 1 & \text{if } \kappa_1 < W_f(w_f, \Phi_f) - W_m(w_m, \Phi_m) \leq \kappa_2 \\ 2 & \text{if } W_f(w_f, \Phi_f) - W_m(w_m, \Phi_m) > \kappa_2 \end{cases} \tag{18}$$

Thus, the distribution of the error term ε corresponding to $I = 1$ of the model (18) corresponds to the error terms distribution of the third equation of the system (17) representing $W_f(w_f, \Phi_f) = W_m(w_m, \Phi_m)$. Thus, the distribution law of the error term u_3 can be recuperated from the results of the probit model estimation (18) [10] . The corresponding mean and variances are straightforwardly calculated as the mean and variance of ε truncated by $I = 1$: $z_1 < \varepsilon \leq z_2$. The derivation of the mean and the variance is outlined in appendixes B.1 and B.2, respectively.

The advantage of using the information from model I (18) is obvious: it leads to the more efficient estimator taking into account the whole sample rather then being based exclusively on the information provided by the selected sample of households whose members give the same answers.

[10] The results of the probit estimation of (18) are not reported in the paper but can be found in Radtchenko(2006) and Kalugina, Radtchenko, Sofer(2007b).

The model (17) is estimated by the method of full information maximum likelihood assuming the system error terms follow a joint trivariate normal distribution with constraints set on the mean μ_{u_3} and variance $\sigma^2_{u_3}$ of the third error term:

$$(u_1, u_2, u_3) \sim N(\mu, \mathbf{\Sigma}) \text{ where } \mu = (0, 0, \mu_{u_3})' \text{ and } \Sigma = \begin{pmatrix} \sigma^2_{u_1} & \sigma_{u_1u_2} & \sigma_{u_1u_3} \\ \sigma_{u_1u_2} & \sigma^2_{u_2} & \sigma_{u_2u_3} \\ \sigma_{u_1u_3} & \sigma_{u_2u_3} & \sigma^2_{u_3} \end{pmatrix}.$$

By its properties, a variance–covariance matrix is symmetric and positive definite. In order to assure the positive definiteness of the estimated matrix, the *Cholesky* decomposition is applied:

$$\Sigma = LL' \tag{19}$$

where L is the lower triangular matrix:

$$L = \begin{pmatrix} l_{11} & 0 & 0 \\ l_{21} & l_{22} & 0 \\ l_{31} & l_{32} & l_{33} \end{pmatrix} \tag{20}$$

Equations (17) and (20) will be estimated simultaneously. The constraint on the variance $\sigma^2_{u_3}$ implies a specific constraint on the *Cholesky* parameters of the matrix L. It is derived in appendix B.3.

Another advantage of using the information coming from the model I (18) is a correction of a possible selection bias. Indeed, it should be noted that using the sub-sample of households giving the equal answers to the satisfaction question (equality index IS equals 1 in accordance with equal utility distribution) can imply a selection bias in labor supply estimation. The results obtained from the ordered probit model (18) allow for its correction. The construction of correction term is given in Appendix C.

Estimation of the sharing rule (θ coefficients) allows to see the direction of the impact of variables Y on the difference between the spouses' shares. Thus, a positive value of a coefficient indicates the husband benefits from an increase in the corresponding variable at his wife's expense. On the other hand, the extent of the benefit can not be ascertained directly from the estimation results, but can be deduced by calculating the marginal effects by using the estimation coefficients.

Noting that $\frac{\partial d}{\partial Y} = \frac{\partial th(Y\theta)}{\partial Y} = \frac{\theta}{ch^2(Y\theta)}$, with Y including the wage rate logarithms, it is possible to calculate the marginal effects of the wage rates and non labour income on the income shares and their difference as follows:

$$\frac{\partial \Delta}{\partial(\ln(w_f))} = \frac{\partial(\Phi d)}{\partial(\ln(w_f))} = \frac{\partial \Phi}{\partial(\ln(w_f))} d + \Phi \frac{\theta_{w_f}}{ch^2(Y\theta)} = w_f T d + \Phi \frac{\theta_{w_f}}{ch^2(Y\theta)}$$

$$\frac{\partial \Delta}{\partial(\ln(w_m))} = \frac{\partial(\Phi d)}{\partial(\ln(w_m))} = \frac{\partial \Phi}{\partial(\ln(w_m))} d + \Phi \frac{\theta_{w_m}}{ch^2(Y\theta)} = w_m T d + \Phi \frac{\theta_{w_m}}{ch^2(Y\theta)},$$

where θ_{w_f}, θ_{w_m}, θ_y are the coefficients corresponding respectively to the wage rate logarithms and non labour income y.

$$\frac{\partial \Delta}{\partial w_f} = \frac{\partial \Delta}{\partial \ln(w_f)} \Big/ w_f = Td + \frac{\Phi}{w_f} \frac{\theta_{w_f}}{ch^2(Y\theta)}$$

$$\frac{\partial \Delta}{\partial w_m} = \frac{\partial \Delta}{\partial \ln(w_m)} \Big/ w_m = Td + \frac{\Phi}{w_m} \frac{\theta_{w_m}}{ch^2(Y\theta)}$$

$$\frac{\partial \Phi_f}{\partial w_i} = \frac{1}{2}\left(\frac{\partial(\Phi - \Delta)}{\partial w_i}\right) = \frac{1}{2}\left(T(1-d) - \frac{\Phi}{w_i} \frac{\theta_{w_i}}{ch^2(Y\theta)}\right)$$

$$\frac{\partial \Phi_m}{\partial w_i} = \frac{1}{2}\left(\frac{\partial(\Phi + \Delta)}{\partial w_i}\right) = \frac{1}{2}\left(T(1+d) + \frac{\Phi}{w_i} \frac{\theta_{w_i}}{ch^2(Y\theta)}\right), \ i = f, \ m$$

The income shares elasticities regarding to the wage rates are

$$\frac{\partial \ln(\Phi_f)}{\partial \ln(w_i)} = \frac{\partial \Phi_f}{\partial w_i} \frac{w_i}{\Phi_f} = \frac{1}{2}\left(\frac{w_i}{\Phi_f} T(1-d) - \frac{\Phi}{\Phi_f} \frac{\theta_{w_i}}{ch^2(Y\theta)}\right)$$

$$\frac{\partial \ln(\Phi_m)}{\partial \ln(w_i)} = \frac{\partial \Phi_m}{\partial w_i}\frac{w_i}{\Phi_m} = \frac{1}{2}\left(\frac{w_i}{\Phi_m}T\left(1+d\right) + \frac{\Phi}{\Phi_m}\frac{\theta_{w_i}}{ch^2(Y\theta)}\right).$$

The non labour income effects are

$$\frac{\partial \Delta}{\partial y} = \frac{\partial (d\Phi)}{\partial y} = d + \Phi\frac{\partial d}{\partial y} = d + \Phi\frac{\theta_y}{ch^2(Y\theta)}$$

$$\frac{\partial \Phi_f}{\partial y} = \frac{1}{2}\left(1 - d - \Phi\frac{\theta_y}{ch^2(Y\theta)}\right)$$

$$\frac{\partial \Phi_m}{\partial y} = \frac{1}{2}\left(1 + d + \Phi\frac{\theta_y}{ch^2(Y\theta)}\right).$$

4 Sharing Rule Identification Results

Below we first present the estimation results of the labour supply equation, (17). The two first equations can be found in Table 1. We also discuss the initial assumption on the comparability of the welfare functions of the two spouses. Table 2 presents the results corresponding to the sharing rule estimation (third equation parameters of (17)). The marginal effects are reported in Table 3. Finally, the *Cholesky* matrix and the parameters of the error terms variance – covariance matrix are given in Table 4.

4.1 Structural Parameters of the Labor Supply Equations

The first two lines of Table 1 report the structural parameters α_i, β_i of the welfare function $W_f\left(w_f, \Phi_f\right)$ and $W_m\left(w_m, \Phi_m\right)$. The parameter estimates are relatively similar across spouses. The confidence intervals of β_f and β_m even intersect at the 1% significance level: (0.4,0.54) for β_f against (0.52,0.75) for β_m. As can be expected from the welfare equality equation, the null assumption that $H_0 : \alpha_f\overline{ln(w_f)} + \beta_f\overline{ln(\Phi_f)} = \alpha_m\overline{ln(w_m)} + \beta_m\overline{ln(\Phi_m)}$ (with $\overline{ln(w_f)}$, $\overline{ln(w_m)}$, $\overline{ln(\Phi_f)}$, $\overline{ln(\Phi_m)}$ calculated at sample means) can not be rejected (the corresponding χ^2 statistics is 0.613). Because our sample is much more heterogenous

in wages and individual budgets than any set represented by individual observations from his or her environement, it is thus very likely that the sets of function values of $W_f(w_f, \Phi_f)$ and $W_m(w_m, \Phi_m)$ are similar. The data justify thus the proposed methodology of studying the intrahousehold inequality via comparison of individual welfare functions based on the differences in levels of satisfaction pertaining to the economic well-being.

Individual characteristics used in the total labour supply estimation (market plus domestic working time) are age, age squared, number of years of education, number of children, number of elderly persons in the household, settlement type and region. The results obtained for two labour supply equations (two first equations of the estimated system (17)) are presented in Table 1.

The main results are consistent with those of Kalugina, Sofer, Radtchenko, 2009: the total labour supplies of both household members are positively correlated with their total individual incomes and negatively correlated with their wage rates. So the positive correlation between leisure and wage rate is a robust result. It confirms that the income in Russia is so weak that the leisure is a very expensive good. Thus, the income effect dominates the substitution effect.

4.2 Sharing Rule Determinants

The vector of the sharing rule parameters includes the wage rates logarithms and their squared terms, non-labour income, husband's age and education and their differences with the same characteristics of his partner, household characteristics (number of children, elderly persons), settlement type and region. The estimation results are reported in Table 2.

The parameters θ in Table 2 correspond to the sharing rule parameters represented by the equation describing shares difference relative to the shares sum: $\frac{\Phi_m - \Phi_f}{\Phi} = \tanh(Y\theta)$. These parameters do not correspond to the sharing rule elasticities and variables Y marginal effects. However, given the increasing and monotonous character of the function tanh, the sign of the coefficients is indicative of the direction of the effects of the explanatory variables.

The linear terms of the wage rate have a negative sign for wives and a positive

Table 1
Estimated Parameters of Husband and Wife' Labour Supply

	Wives, $H_f/100$	Husbands, $H_m/100$
Variable	Coefficient	Coefficient
Ln of one's wage rate (α_i)	**-0.210*** **	**-0.945*** **
Ln of one's full income (β_i)	**0.462*** **	**0.621*** **
Individual and household characteristics		
One's age/10	0.219**	0.186
One's squared age/100	-0.021*	-0.028*
Number of years of education/10	-0.1935***	0.125
Number of children 0-7 years old	0.162**	0.227**
Number of children 7-18 years old	0.061*	0.109*
Number of elderly persons in the household	0.051	-0.200**
Region of Residence		
Rural	0.023	-0.283**
North Caucasian	0.038	-0.465*
Centre	0.188	-0.379
Volga-Vaytski and Volga Basin	0.159	-0.332
Moscow - St-Petersburg	0.187*	-0.380
Northern and North Western	0.278*	-0.494*
The Urals	-0.059	-0.039
Western Siberia	-0.021	0.160
Eastern Siberia	-	-
Round		
Round V	0.259***	-0.328*
Round VI	-0.155***	-0.281
Round VII	-	-
Round VIII	0.159**	-0.525***
Ratio1	0.103	-3.214***
Intercept(Q_i)	**3*** **	**11***
Number of observations	854	854

** Significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.*

one for husband. The negative impact of the wife's wage rate on the difference between shares and the symmetric impact of the husband's wage are confirmed by the marginal effects calculated at mean values of the whole sample. As in KRS(2009), we find that the effect of the age difference on the sharing rule entails a greater bargaining power of wives who are relatively younger

than their spouse. Another finding in common is the impact of education on the sharing rule. Indeed, one's education favours his or her bargaining power: An additional year of schooling by the husband has a positive impact on his budget share. The reverse is also true, although the coefficient is not precisely estimated.

The number of young children (less than 7) has a negative impact on the difference in shares. That is, it favours the wives' share relative to the husbands'. The effect of number of children on wives' individual budget might reflect both changes in her bargaining power as well as her share in their financing. In the latter case, a larger share might simply indicate increased children consumption.

In its current form, the collective model of labor supply does not lend itself easily to the inclusion of household public good such as children or other dependants [11] . The studies that try to circumvent such a constraint imply too strong theoretical and empirical restrictions: a solution proposed by Chiappori and Ekeland (2002) requires restrictions on marginal utilities and existence of a good consumed by only one household member; Michaud and Vermeulen (2006) propose a model that allows for externalities while assuming that the preferences of individuals living in couples and those living alone are identical. Thus, individual budget shares include public goods expenditures which are not identifiable.

We find that the sharing is more advantageous for the husband in rural settlements. A similar finding holds for households living in northern regions. Thus, the interregional differentials in real income, wage and unemployment rates may impact the intrahousehold welfare distribution. The North region, for example, characterized by abundant natural resources, was not as severely hit as other regions by reforms that occurred during the transition period.

[11] It is generally assumed in bargaining models that only the principal members of the household (husband and wife) participate in the decision-making process. The elderly parents and grow-up children may influence the decision-making process (see, *e.g.*, Fortin, Dauphin, El Lhaga and Lacroix,(2008)). We omit this possibility in order to keep the model tractable. Indeed, most analyses of the collective model with multiple decision-makers focus on consumption data rather than labor market behavior which is crucial to our method of sharing rule identification

Table 2
Sharing Rule Estimation represented by $(\Phi_m - \Phi_f) \Big/ \Phi = th(Y\theta)$

Explanatory variables, Y	**Parameters** , θ
Ln of woman's wage rate	**-0.248*** **
Ln of man's wage rate	**0.692*** **
Ln of woman's wage rate squared	**0.040** **
Ln of man's wage rate squared	**-0.034*** **
Non-labour income	-0.005
Individual and household characteristics	
Man's age/10	0.039
Age difference/10[a]	0.089**
Years of man's education/10	0.101*
Woman has higher degree of education than man	-0.023
Number of children 0-7 years old	-0.069*
Number of children 7-18 years old	-0.065
Number of elderly persons in the household	0.258
Region of Residence	
Rural	0.281*
North Caucasian	0.424
Centre	0.445
Volga-Vaytski and Volga Basin	0.391
Moscow - St-Petersburg	0.403
Northern and North Western	0.623*
The Urals	-0.032
Western Siberia	-0.205
Eastern Siberia	-
Round	
Round V	0.271
Round VI	0.319
Round VII	-
Round VIII	0.575**
Intercept	-1.936***
Number of observations	854

** Significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.*
Φ_m and Φ_f are man's and woman's budget shares of the full household income
[a] *Age difference: the difference between woman's and man's age.*

Table 3 shows the predicted marginal effects of wage rates and non labour income on the wives and husbands' individual shares and the shares difference as well as their elasticities with respect to the wage rates. The effects are calculated by using the prediction of the shares difference Δ for an average Russian household represented by a 38-year old woman earning 9 rubles per hour, 40- year old man earning 11 rubles per hour and a single 7-year (or older) child living in a city of Western Siberia. The wife, with 13 years of schooling, has a higher degree of education than her husband. The mean values are calculated for the whole sample, that is the sample including not only the couples reporting the equal satisfaction, but also the households wih unequal utility distribution (1914 observations); the prediction is based upon round 8. The predicted sharing gives approximately an equal income distribution between two partners with a wive enjoying a slight advantage of 4 %: $\Delta/\Phi = -0.04^{***}$, $\Phi_f = 13802^{***}$, $\Phi_m = 12712^{***}$.

The wives' wage impact on the difference $\Delta = \Phi_m - \Phi_f$ is, as expected, negative. The husband's wage has a positive and stronger impact in absolute value. These results show the positive effect of one's wage on one's share. A unit increase in the hourly wage rate of a spouse automatically increases full-budget by 672 roubles ($T = 672$ hours per month). The table indicates that an increase in the wives' wage rate would have increased their individual budgets by 452 roubles and that of their husbands by 220 roubles. This suggests that women do not behave in an egoistic manner. The marginal impact of an increase in husbands' hourly wage rates is completely different. Not only they would keep the whole gain but they would benefit as well from redistribution of the resources available without their wage rate increase: husbands' individual budget would increase by 937 roubles while wives' would decrease by 266 roubles. Note that while "measured" in roubles, the redistribution could be made in a nonmonetary way, for example by decreasing of wives' leisure and increasing her allocation of time to the domestic work (See (3) for the definition of individual budget). The results suggest thus that husbands' wage increase not only their income but also their bargaining power. This result is confirmed by the calculated elasticities: the wives' budget elasticity with respect to the husbands' wage is strong, negative and significant. However, as it could be expected, one's budget elasticity with respect to one's own wage is more important compared to the partner's budget elasticity. The strongest is the elasticity of husbands' budget with respect to their wage rate.

Table 3
Sharing rule: marginal effects and elasticities ; $\Delta = \Phi_m - \Phi_f$

Effects	**Predicted values**
$\partial\Delta/\partial w_f$	-232***
$\partial\Delta/\partial w_m$	1203***
$\partial\Delta/\partial y$	-123
$\partial\Phi_f/\partial w_f$	452***
$\partial\Phi_f/\partial w_m$	-266***
$\partial\Phi_m/\partial w_f$	220
$\partial\Phi_m/\partial w_m$	937***
$\partial\Phi_f/\partial y$	62
$\partial\Phi_m/\partial y$	-61
$\partial ln\Phi_f/\partial lnw_f$	0.3***
$\partial ln\Phi_f/\partial lnw_m$	-0.22***
$\partial ln\Phi_m/\partial lnw_f$	0.16***
$\partial ln\Phi_m/\partial lnw_m$	0.84***
Number of observations	1914

w_j: wage rate, $j = f,\ m$
y: non labor income
Φ_m, Φ_f: man's and woman's shares of the full household income

4.3 Covariance Matrix

Table 4 gives the estimated parameters of the variance-covariance matrix of the system (17) error terms.

Table 4
Cholesky Matrix L

	u_1	u_2	u_3^*
u_1	0.680		
	(0.282)		
u_2	1.418	0.776	
	(0.628)	(0.193)	
u_3^*	-0.868	-0.432	**
	(0.118)	(0.200)	

Covariance Matrix: Σ

	u_1	u_2	u_3^*
u_1	0.463	1.795	-0.591
u_2	1.795	2.613	-1.566
u_3^*	-0.591	-1.566	1

Standard errors in parentheses.
$u_3^* = u_3 \Big/ \sqrt{Var(\varepsilon | z_1 < \varepsilon < z_2)}$; $Var(u_3^*) = 1$
** $l_{33} = \sqrt{1 - (l_{31})^2 - (l_{32})^2}$

The correlation between the error terms of labour supply equations $\sigma_{u_1 u_2}$ is positive but weakly significant. The correlations between the error terms of these equations with the equality equation error term ($\sigma_{u_1 u_3}$,$\sigma_{u_2 u_3}$) are negative (significant at 10% and 1% levels respectively). These negative correlations mean that unobserved effects influencing positively individual labor supply destabilises utility equality of the two partners. This finding is coherent with the hypothesis of utility increase in leisure.

CONCLUSION

The empirical studies based on the collective model proposed by Chiapori are limited by the fact that the sharing rule of intrahousehold resource allocation can only be identified up to a constant when focusing on labour supply information. This restriction is due to unavailability of data on individual consumption. In this paper we propose an innovative approach. We show that the sharing rule can be fully identified if we use subjective data because the latter impose an additional behavioural constraint.

The method relies on the definition of the intra household inequality as equality of utility as discussed in Kalugina, Radtchenko, Sofer (2007b) and Radtchenko (2006), and using only households reporting the same level of satisfaction. We first review the intrahousehold inequality definitions proposed by Kalugina, Radtchenko, Sofer and discuss the nature of the information provided by the subjective questions on income and satisfaction. We focus on the economic well-being and argue that the variations in the answers on the satisfaction question are due basically to the variations in spouses' relative wages and incomes. While attributing the most important impact to economic welfare, we do not constraint however other effects to be zero.

The estimation based on the proposed methodology predicts that income is roughly equally distributed within a typical Russian household in 1998, with the wife enjoying perhaps a slight advantage of 4 %. The main results show that an increase in the wife's wage rate benefits both spouses with a greater share allocated to her. By contrast, an increase in the husband's wage rate translates into his budget share and leads to increasing of his bargaining power regarding other household resources.

A significant impact of the wage difference within the household is consistent with KRS(2009)'s result according to which the wage difference appears to be a strong determinant of the intra-household sharing of resources. As in KRS(2009), we find that the effect of the age difference on the sharing rule entails a greater bargaining power for wives who are relatively younger than their spouse. Another finding in common is the impact of education on the sharing rule. Indeed, one's education favours his or her bargaining power: An additional year of schooling by the husband has a positive impact on his budget share. The reverse is also true, although the coefficient is not precisely estimated.

The qualitative and quantitative similarities of the results of the sharing rule estimation to those obtained in KRS (2009) in spite of conceptual differences in intrahousehold equality definitions used in the papers and substantial differences in econometric modelling support the robustness of the general strategy of using subjective data as an additional source of information. The choice of the method will be conditioned then by the data availability on satisfaction or income information. The advantage of the method related to the satisfaction question is that its interpretation is more straightforward and its use does not involve measuring individual budget shares, thus avoiding potential measurement errors.

A substantial empirical difference found when comparing the results given by two different methods is shown regarding pre-schoolers. In contrast with KRS(2009), we find a negative impact on the difference between husbands and wives' budgets. This result is presumably consistent with wives being responsible for children consumption. However the inconsistency between the results obtained by the two different methods indicates that, in its current form, the collective model of labor supply does not lend itself easily to the inclusion of household public good such as children or other dependants. Indeed, individual budget shares include public goods expenditures which are not identified. Future research should focus on finding empirical strategies to better understand the interactions between spouses' behaviour toward public goods.

References

Apps P. et Rees R. (1997), "Collective Labor Supply and Household Production", *Journal of Political Economy*, 105, pp. 178-190.

Chiappori P.A. (1988), " Rational household labor supply ", *Econometrica*, 56, p.63-89.

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

Chiappori P-A. (1997), "Introducing Household Production in Collective Models of Labor Supply", *Journal of Political Economy*, 105, pp. 191-209.

Chiappori P-A., Ekeland I. (2002), " The micro economics of group behavior : identification ", *mimeo*, Chicago, University of Chicago.

Chiappori P-A., Fortin, B. et Lacroix G. (2002), "Marriage Market, Divorce Legislation and Household Labor Supply", *Journal of Political Economy,* 110, pp.37-72.

Clark A., Couprie H. et Sofer C. (2004), "La modélisation collective de l'offre de travail. Mise en perspective et application aux données britanniques", *Revue Economique*, 55, n ° 4, p.767-789.

Fortin B., Dauphine A., Lacroix G., El Lahga A.-R. (2008) "Assessing the Number of Household Decision-Makers", *mimeo*, Laval University.

Gronau R. (1977), "Leisure, homeproduction and work – the theory of the allocation of time", *JPE* 85(6).

Kalugina E., Radtchenko N., Sofer C (2009) "How Do Spouses Share their Full Income? Identification of the Sharing Rule Using Self-Reported Income", *Review of Income and Wealth, forthcoming.*

Kalugina E., Radtchenko N., Sofer C (2007a) " Une analyse du partage intrafamilial du revenu à partir de données subjectives", *Economie et Prévision*, n ° 186.

Kalugina E., Radtchenko N., Sofer C (2007b) "Measuring Members

Shares within the Household: why can we Use Subjective Data?", manuscript, *Université Paris I -Panthéon –Sorbonne.*

Lacroix G, Radtchenko N. (2008), "The Changing Intra-Household Resource Allocation in Russia", IZA Discussion Paper No. 3733.

Michaud P.-C., Vermeulen F. (2006), "A Collective Labor Supply Model: Identification and Estimation in the Presence of Externalities by Means of Panel Data", Rand Working Paper, WR-406, July.

Radtchenko N. (2006), "Offre de travail individuel et "collective" : Applications empiriques à l'aide de données russes ", thèse de doctorat, *Université Paris I -Panthéon -Sorbonne.*

Rapoport B., Sofer C. et Solaz A. (2003), "Household Production in a Collective Model: Some New Results", TEAM Working Paper, Université Paris 1-Panthéon-Sorbonne.

Rapoport B., Sofer C. et Solaz A. (2006), "La production domestique dans les modèles collectifs", *Actualité Economique,* Volume 82, numéro 1-2.

APPENDIX A

Table A.1. Descriptive statistics of the key variables

	Femmes			Hommes		
Round	VI	VII	VIII	VI	VII	VIII
Variable	Mean (Standart Deviation)					
Market time/week h_i, hrs	39.5 (12.23)	38.41 (14.68)	38.78 (15.38)	45.22 (12.99)	44.75 (16.84)	44.72 (17.25)
Domestic time/week hh_i, hrs	42.9 (30.4)	45 (30.7)	46.87 (29.8)	13.74 (17.52)	15.71 (19.36)	14.72 (16.47)
Total working time/week H_i, hrs(31.53)	82.36 (31.49)	83.23 (31.92)	85.66 (22.48)	58.95 (24.93)	60.43 (22.69)	59.39
Hourly wage w_i, roubles*	7 (17)	6.12 (14,5)	3.87 (10.9)	12.7 (55.5)	10.46 (36)	7.8 (45)
Hh total monthly income, roubles*	2887 (6145)	2696 (5878)	2196 (14484)	2887 (6145)	2696 (5878)	2196 (14484)

Source : RLMS (rounds VI-VIII)
*wage rates are given in roubles of 2000

Table A.2. Satisfaction Question

Round	V	VI	VII	VIII	Whole Sample
Variable	Number %				
Not at all satisfied	127 (23,02)	119 (19,57)	77 (17,95)	111 (23,57)	434 (19,39)
Less than satisfied	318 (43,56)	228 (37,50)	170 (39,63)	176 (37,37)	892 (39,86)
Both yes and no	159 (21,78)	158 (25,99)	111 (25,87)	109 (23,14)	537 (23,99)
Rather satisfied	94 (12,88)	80 (13,16)	52 (12,12)	64 (13,59)	290 (12,96)
Fully satisfied	32 (4,38)	23 (3,78)	19 (4,43)	11 (2,34)	85 (3,80)
Total	730 (100)	608 (100)	429 (100)	471 (100)	2238 (100)

Table A.3. Within household discrepancies in self reported satisfaction

Round	V	VI	VII	VIII
Wife score - husband score Variable	Number %			
Wife is two or more steps less satisfied	80 (11,07)	50 (8,25)	39 (9,11)	49 (10,40)
Wife is one step less satisfied	133 (18,40)	139 (22,94)	101 (23,60)	120 (25,48)
No difference	326 (45,09)	274 (45,21)	201 (46,96)	203 (43,10)
Wife is one step more satisfied	137 (18,95)	105 (17,33)	61 (14,25)	76 (16,14)
Wife is two or more steps more satisfied	47 (6,50)	38 (6,27)	26 (6,07)	23 (4,88)
Total number of households	723 (100)	606 (100)	428 (100)	471 (100)

APPENDIX B

B.1. The mean of the truncated low of the standard normal distribution is found using the following property of the standard normal low density function $f(\varepsilon) = \frac{1}{\sqrt{2\pi}} \exp(-\frac{\varepsilon^2}{2})$: $\frac{\partial f(\varepsilon)}{\partial \varepsilon} = -\varepsilon f(\varepsilon)$.

$$E(u_3) = E(\varepsilon|IS = 1) = E(\varepsilon|z_1 < \varepsilon < z_2) = \int_{z_1}^{z_2} \varepsilon f(\varepsilon\,|z_1 < \varepsilon < z_2)d\varepsilon =$$

$$= \int_{z_1}^{z_2} \varepsilon \frac{f(\varepsilon)}{P(z_1 < \varepsilon < z_2)} d\varepsilon = \frac{1}{F(z_2) - F(z_1)} \int_{z_1}^{z_2} \varepsilon f(\varepsilon) d\varepsilon =$$

$$= \frac{1}{F(z_2) - F(z_1)} \int_{z_1}^{z_2} (-f'(\varepsilon))\, d\varepsilon = \frac{1}{F(z_2) - F(z_1)} \left[-f(\varepsilon)\right]_{z_1}^{z_2} =$$

$$= \frac{f(z_1) - f(z_2)}{F(z_2) - F(z_1)} \tag{B1}$$

where $F(.)$ is the standard normal cumulative density function.

B.2. The variance is calculated [12] by the same approach:

$$Var(u_3) = (\varepsilon | IS = 1) = Var(\varepsilon | z_1 < \varepsilon < z_2) =$$

$$= E(\varepsilon^2 | z_1 < \varepsilon < z_2) - \left(E(\varepsilon | z_1 < \varepsilon < z_2)\right)^2 \tag{B2}$$

The second term of (B2) is defined by (B1). The first term is found by integrating by parts:

$$E(\varepsilon^2 | k_1 < \varepsilon < k_2) = \frac{1}{F(z_2) - F(z_1)} \int_{z_1}^{z_2} (-\varepsilon f'(\varepsilon))\, d\varepsilon =$$

$$= \frac{1}{F(z_2) - F(z_1)} \left(\left[-\varepsilon f(\varepsilon)\right]_{z_1}^{z_2} + \int_{z_1}^{z_2} (f(\varepsilon))\, d\varepsilon \right) =$$

$$= \frac{1}{F(z_2) - F(z_1)} \left(-\varepsilon f(z_2) + \varepsilon f(z_1) + F(z_2) - F(z_1)\right) =$$

$$= 1 + \frac{z_1 f(z_1) - z_2 f(z_2)}{F(z_2) - F(z_1)} \tag{B3}$$

Finally, using (B1)-(B3) the variance of the truncated low is found as

$$Var(u_3) = 1 + \frac{z_1 f(z_1) - z_2 f(z_2)}{F(z_2) - F(z_1)} - \left(\frac{f(z_1) - f(z_2)}{F(z_2) - F(z_1)} \right)^2$$

[12] Up to a constant

B.3. The constraint on $\sigma^2_{u_3} = Var(\varepsilon | z_1 < \varepsilon < z_2)$ is respected by normalizing the error term of the third equation by $u^*_3 = \frac{u_3}{\sqrt{Var(\varepsilon | z_1 < \varepsilon < z_2)}}$. Constrained (and normalized to 1) variance of u^*_3 implies a constraint on *Cholesky* matrix parameters L. This constraint is found setting the relationship between $Var(u^*_3)$ and matrix L elements:

$$Var(u_3 \Big/ \sqrt{Var(\varepsilon | z_1 < \varepsilon < z_2)}) = (l_{31})^2 + (l_{32})^2 + (l_{33})^2,$$

which implies the following restriction on *Cholesky* matrix parameters

$$(l_{31})^2 + (l_{32})^2 + (l_{33})^2 = 1$$

A constraint on l_{33} is then deduced:

$$l_{33} = \sqrt{1 - (l_{31})^2 - (l_{32})^2}.$$

APPENDIX C

The correction term *Ratio1* of the selection bias in the labor supply equations is constructed as follows:

$$E(u_i | IS = 1) = E(E(u_i | \varepsilon) | IS = 1) = M_1(\sigma_{u_i u_3}) E(\varepsilon | IS = 1),$$

where $M_1(\sigma_{u_i u_3})$ is a coefficient depending on the covariance between ε and u_i to be estimated, *i = 1, 2.*

Then the correction term *Ratio1* of labor supply equations selection bias is the mean of the truncated law of the ordered probit equation error term developed in Appendix B.1:

$$Ratio1 = E(\varepsilon | IS = 1) = E(\varepsilon | z_1 < \varepsilon < z_2) = \frac{f(z_1) - f(z_2)}{F(z_2) - F(z_1)},$$

where $f(.)$, $F(.)$ are respectively the density and cumulative density functions of the standard normal distribution.