

Lacroix, Guy; Radtchenko, Natalia

**Working Paper**

## The changing intra-household resource allocation in Russia

IZA Discussion Papers, No. 3733

**Provided in Cooperation with:**

IZA – Institute of Labor Economics

*Suggested Citation:* Lacroix, Guy; Radtchenko, Natalia (2008) : The changing intra-household resource allocation in Russia, IZA Discussion Papers, No. 3733, Institute for the Study of Labor (IZA), Bonn,  
<https://nbn-resolving.de/urn:nbn:de:101:1-20081014382>

This Version is available at:

<https://hdl.handle.net/10419/34889>

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IZA DP No. 3733

## The Changing Intra-Household Resource Allocation in Russia

Guy Lacroix  
Natalia Radtchenko

September 2008

# The Changing Intra-Household Resource Allocation in Russia

**Guy Lacroix**

*CIRPÉE, Université Laval  
and IZA*

**Natalia Radtchenko**

*CREST & CES, Université Paris 1-Panthéon-Sorbonne  
and CNRS*

Discussion Paper No. 3733  
September 2008

IZA

P.O. Box 7240  
53072 Bonn  
Germany

Phone: +49-228-3894-0  
Fax: +49-228-3894-180  
E-mail: [iza@iza.org](mailto:iza@iza.org)

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## ABSTRACT

### **The Changing Intra-Household Resource Allocation in Russia<sup>\*</sup>**

During the transition toward a market economy, Russian workers have had to face important structural changes in the labour market as well as dramatic changes in their real earnings. In the process, the wage gap between men and women has varied wildly over that period. In recent years, young women have embraced professional careers, are more mobile on the labour market, and tend to delay the birth of their first child. All these trends are likely to influence intra-household relations and consequently the family decision process. To investigate this matter, we estimate a household collective labour supply model. We generalize the specification so as to allow the sharing rule to change in a discrete manner between the pre and post 1998 financial crisis periods. The parameters of the sharing-rule indicate that the households have shifted to a new equilibrium in the post-1998 period. Indeed, husbands have become more egotistic and wives more altruistic: An increase in their relative wage translates into a smaller/larger transfer to their spouse.

JEL Classification: D1, J22, C5

Keywords: collective model, sharing rule, Russian economic crisis

Corresponding author:

Guy Lacroix  
Department of Economics  
Pavillon de Sève  
Université Laval  
Québec (Québec) G1K 7P4  
Canada  
E-mail: [guy.lacroix@ecn.ulaval.ca](mailto:guy.lacroix@ecn.ulaval.ca)

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<sup>\*</sup> We are grateful to Thierry Kamionka and Catherine Sofer for useful comments on a preliminary version of the paper. Comments from participants at the ESPE 2006 Meeting in Verona, Italy, are also acknowledged.

## 1 Introduction

The Russian economy has witnessed dramatic changes over the course of the last 15–20 years. During the transition toward a market economy, workers have had to face important decreases in their real earnings as well as widespread unemployment. Indeed, Thomas and Stillman (2004) report that in the last half of 1998 alone, real GDP collapsed by as much as 30%. The collapse can be traced back to the price liberalization of January 1992 and a series of sweeping economic reforms. These included the elimination of most food and fuel subsidies, the use of freely fluctuating market prices and the privatization of many state enterprises. According to the United Nations (1998), the economic downfall that culminated with the 1998 financial crisis can be intimately linked to structural and institutional deficiencies. Indeed, no safety nets were in place to prevent households from falling into poverty [Lokshin and Ravallion (2000)]. Furthermore, wage arrears and in-kind payments became widespread practice by private firms and public institutions alike, thus increasing income uncertainty [Grogan (2006), Mroz and Popkin (1995), Gerry, Li and Kim (2004)]. For the majority of Russians, the impact of the 1988 crisis was disastrous. The debacle of commercial banks deprived many households of their hard earned savings during the soviet period and seriously undermined their confidence vis-à-vis financial institutions.

Many reckon that women have suffered more than men from the economic collapse [Glinskaya and Mroz (2000)]. Indeed, as old enterprises closed down while others faced increased competition, centrally set wages gave way to remuneration based on marginal productivity.<sup>1</sup> Because women were traditionally over-represented in low-paid jobs, market forces may have depressed their relative wages further. Households thus needed to find strategies to deal with unexpected income fluctuations and to maintain a minimum level of consumption. Using data from the Russian Longitudinal Monitoring Survey (RLMS), Lokshin and Yemtsov (2001) have found that in many cases women turned to informal social networks and to government organizations for help. Women were also more likely than men to reduce expenditures on food and clothing. Asymmetric gender responses may partly be explained by the fact that

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Natalia.Radtchenko@malix.univ-paris1.fr (Natalia Radtchenko).

<sup>1</sup> Within three years, from 1992 to 1995, the proportion of workers employed in private enterprises rose from 5% to 38%.

women are better informed about the household budget and market prices, but it is also compatible with men having a greater say with respect to the intra-household allocation of resources.

Enduring economic hardship and fundamental structural changes may have induced the labour market to shift to a new equilibrium. Behavioural changes, in return, can induce changes in social norms which modify the role of partners within the households. During the communist period, great emphasis was placed on employment both as a right and a duty equally for men and women. However, society remained predominantly patriarchal and gender relations within the household continued to reflect a strong “male breadwinner” model [Paci (2002), Glinskaya and Mroz (2000)]. In recent years, women’s behaviour on the labour market has witnessed important changes: on the one hand, a significant proportion of women have withdrawn from the working force to become housewives. On the other hand, young women appear to be more active than older women. They are more inclined to embrace professional careers, are more mobile on the labour market, and tend to delay the birth of their first child. Finally, Ashwin (2004) has underlined the fact that the traditional role of “breadwinner” can seriously be compromised if the male spouse is unable to secure a high wage, often the cause of his domestic marginalisation.

All these trends inevitably influence intra-household relations and consequently the decision process. Thus behavioral changes on the labour market may reflect not only gender-biased labour markets adjustments, but also changing bargaining power within households.<sup>2</sup> Assessing the extent to which observed behavioural changes are driven by changing intra-household bargaining power is a difficult task. Yet the wild fluctuations in the wage rates over much of the 1990s and the important changes in the labour market participation rates offer a unique opportunity to investigate the inner functioning of the Russian households. To achieve this, one must be willing to assume that the observed household outcomes are Pareto-efficient (“collectively rational”). If one focuses exclusively on the labour supply behaviour, Chiappori(1988, 1992) has shown that it is possible to recover (up to a constant) the so-called income sharing-rule that supports the observed outcomes. This result is particularly useful in

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<sup>2</sup> Gerry et al. (2004) provide evidence that the wage gap is unevenly distributed, with women at the lower end of the distribution suffering most. Their results show that managers very likely used wage arrears and in-kind payments to attenuate the wage gap at the bottom end of the wage distribution.

our context. Indeed, the dramatic changes that have occurred in the relative wage rates during the 1990s are bound to have impacted the sharing-rule between spouses. We thus seek to investigate this issue through the estimation of a household collective labour supply model. Such models have been widely used in the recent empirical literature. In the majority of cases, though, the analyses have focused exclusively on households in which both spouses participate on the labour market [*e.g.*, Chiappori, Fortin and Lacroix (2002)]. In addition to potential selection biases and efficiency loss, focusing exclusively on interior solutions leaves out an important margin of adjustment.

Our strategy consists in estimating a labour supply model that allows for corner solutions for both husbands and wives. The model is inspired from Bloemem (2008). We generalize the specification so as to allow the sharing rule to change in a discrete manner between the pre and post 1998 periods. The parameter estimates associated with the structural shift can be directly interpreted as a change in the bargaining power within households. The wage rates and the labour supply functions are estimated simultaneously. We also account for non-parametric unobserved heterogeneity both in the wage and labour supply equations.

On the whole, the behaviour of Russian households can be relatively well approximated by the collective model.<sup>3</sup> The parameters of the sharing-rule indicate that the households have shifted to a new equilibrium in the post-1998 economic crisis. Indeed, husbands have become more egoistic and wives more altruistic: An increase in their relative wage translates into a smaller/larger transfer to their spouse.

The paper is organised as follows. The next section presents the data and discusses the main features of the 1998 financial crisis in Russia and stresses the manner in which it may have impacted intrahousehold bargaining power. In Section 3 we present the household collective labour supply model and indicate how the sharing rule can be made period-specific. The econometric and statistical specifications are presented in section 4. Finally, Section 5 discusses the main empirical results.

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<sup>3</sup> Recently, Vermeulen, Cherchye, Rock and Sabbe (2005, 2008) have used consumption data from the RLMS to test the collective model using non-parametric (Integer Programming) tests. Their results indicate that the collective model is compatible with the data.

## 2 Data and Institutional Environment

The data we use are drawn from the Russian Longitudinal Monitoring Survey. The RLMS is a household-based representative survey of Russia designed to measure the effects of the reforms implemented through the 1990s on the economic well-being of households and individuals. The data collection project started in 1992 and currently holds as many as 13 waves of data (1992–2004).<sup>4</sup> Data collection was held in two distinct phases. Phase I covers the years 1992–1994 while Phase II covers the period from 1994 (October) until 2004. Because Phases I and II data do not perfectly overlap we focus exclusively on phase II data. The collection schedule is reported in Table 1. Unfortunately, no data were collected in the years prior to and following the 1998 financial crisis.

Table 1  
Collection schedule of the RLMS data, Phase II

Round	V	VI	VII	VIII	IX	X	XI	XII	XIII
Year	1994	1995	1996	1998	2000	2001	2002	2003	2004
<i>Number of individuals: 8700</i>									

Our sample is composed of intact couples in which wives and husbands are aged between 16 and 55 and 16 and 60, respectively. We exclude full-time students as well as those who are unable to work for health reasons, women on maternity leave, and finally those who are involuntarily unemployed (*i.e.* unemployed and looking for a job). The latter are excluded to insure that non-employment is a choice rather than a constraint.

### 2.1 The Evolving Labour Market

As mentioned earlier, the sweeping reforms that were introduced in the 1990s up until the major financial crisis of 1998 have probably triggered changes in the institutional environment and social norms that may be reflected in the

<sup>4</sup> All the information on the RLMS data may be found on the project's web page: <http://www.cpc.unc.edu/rlms>.

labour market behaviour of spouses. *Prima facie* evidence on the changing labour market adjustments is provided in Figure 1. The figure depicts the participation rates of male and female spouses for the years 1994-2004 as well as the husbands/wives wage ratio. Between 1994 and 1996, husbands have

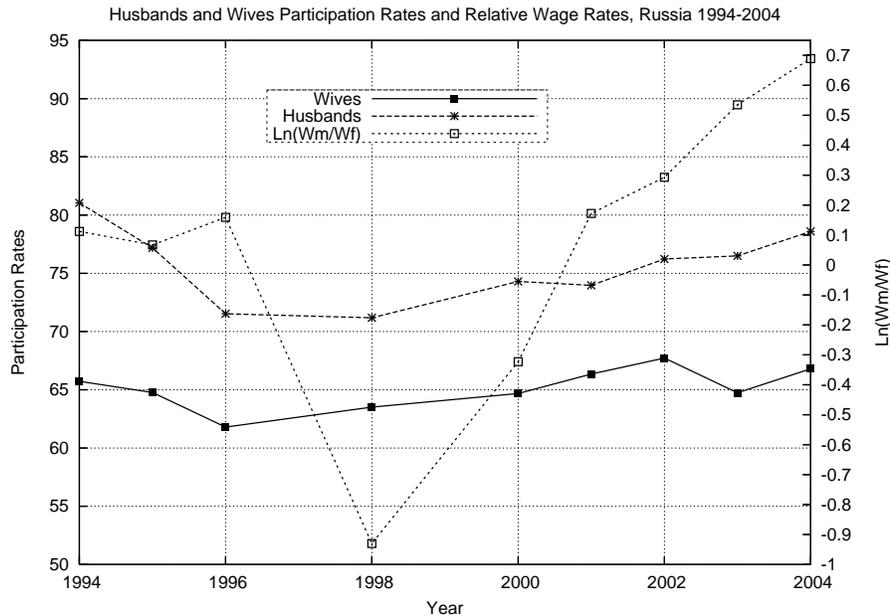


Fig. 1. Participation rates, relative wages

witnessed a decline of 10 percentage points in their participation rates. The decline was much less pronounced for wives (3 percentage points) over the same period. Husbands' participation rates remained relatively constant between 1996 and 1998. In the following years, their participation rates have almost returned to their 1994 level. Wives' participation rate have followed an upward trend between 1996 and 2002. After a small decline in 2003, their participation rates in 2004 are slightly above those of 1994.

The dotted line in the figure depicts the relative (husband/wife) hourly (log) wage ratios.<sup>5</sup> The scale of the dotted line appears on the right-hand side of

<sup>5</sup> The period 1994-2004 was plagued by very high inflation. During the transition

the figure. Prior to the crisis, wives' wage rates amounted to more or less 90% of their husbands' wage rates but were declining slowly. During the crisis, wage rates decreased dramatically. The decrease of men's wages was much stronger than that of women. Consequently, wives' wage rates nearly doubled those of their husbands in 1998. Some have suggested that this is partly explained by the collapse of the high-wage sectors that were traditionally reserved to men [see Goskomstat Rossii (1999), Rossi (2005)].

These trends are also confirmed by simple regression analyses. Table 2 reports the results of regressing the (log) ratio of husband/wife wage rates on a series of exogenous variables. These include each spouse's age and schooling, and a series of regional and year dummy variables. According to the parameter estimates, the wage gap decreases with the husbands age and his wife's schooling level, but increases with his own level of schooling. Households living in the Volga region have larger wage gaps than those living Eastern Siberia/Far East region, while the converse holds for those living in Western Siberia. The year dummy variables are consistent with the pattern depicted in Figure 1. Relative to 1998, the (log) wage gap varies between 23% and 30% in the years 1994–1996, decreases significantly in 1998, and increases steadily between 2000 and 2004.<sup>6</sup>

Table 3 reports the parameter estimates of pooled probit regressions on participation for each spouse separately. These regressions are only intended to confirm or invalidate the trends observed in Figure 1. In both cases, age and education are important determinants of labour force participation. Likewise, most regional dummy variables are statistically significant. Interestingly, wives living in the Moscow-St-Petersberg regions are no more likely to work than those living in Eastern Siberia, while husbands are more likely to work than in any other part of the country. Once again, the year dummy variable are consistent with the pattern depicted in Figure 1: Wives' participation rates decline slowly at first, flatten out between 1996 and 2000, and by 2004 are more or less equal to their pre-1998 level. Husbands' participation rates are

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phase sellers would post prices in “units” that needed to be translated into roubles using the Rouble/US \$ exchange rate. We thus convert the wage rates into US\$ using the official exchange rates [see Goskomstat Rossii (?)].

<sup>6</sup> Glinskaya and Mroz (2000) report very similar wage gaps for the years 1992–1995 using RMLS data. See also Gerry et al. (2004) for a detailed analysis of the gender wage gap for the years 1994–1998.

Table 2  
Wage Regression:  $\ln(W_m/W_f)$

Variable	Para.	Std.	T-stat
<i>Individual characteristics</i>			
Intercept	-0.58	0.16	-3.61
Age - Husband	-0.01	0.00	-5.10
Age - Wife	0.00	0.00	0.48
Schooling - Husband	0.02	0.01	2.72
Schooling - Wife	-0.02	0.01	-2.26
<i>Region of residence</i>			
Moscow - St-Petersberg	-0.03	0.09	-0.35
North /Northwestern	0.18	0.11	1.65
Central / Black Sea	0.14	0.08	1.72
Volga/Viask/Volga Basin	0.17	0.09	2.05
North Caucas	0.07	0.10	0.70
Ural	0.02	0.09	0.21
Western Siberia	-0.23	0.10	-2.23
Eastern Siberia		<i>omitted</i>	
<i>Year dummies</i>			
1994	1.30	0.09	14.60
1995	1.23	0.11	11.43
1996	1.20	0.09	13.14
1998		<i>omitted</i>	
2000	0.70	0.08	8.29
2001	1.22	0.09	14.09
2002	1.36	0.08	16.01
2003	1.60	0.08	19.00
2004	1.77	0.08	21.09
# Observations		3 083	
R <sup>2</sup>		17.7%	

also well captured by the year dummy variables. The sharp decline is well captured by the parameter estimates of 1994–2000 and the upward trend is also nicely captured by the 2001–2004 year dummies.

As a last piece of evidence, Table 4 reports the results of fitting a pooled tobit model on the weekly hours of work using the same specification as in the probit regressions. Once again, age and schooling appear to be important determinants of the weekly hours of work and exhibit the usual concave shape.

Table 3  
Pooled Probit Regressions: Participation

Variable	Wives		Husbands	
	Para.	T-stat	Para.	T-stat
<i>Individual characteristics</i>				
Intercept	-5.33	-24.20	-1.00	-4.82
Age	0.21	23.11	0.08	9.11
Age <sup>2</sup>	0.00	-20.65	0.00	-10.94
Schooling	0.17	7.67	0.04	2.07
Schooling <sup>2</sup>	0.00	-5.25	0.00	-0.51
<i>Region of residence</i>				
Moscow - St-Petersberg	0.01	0.18	0.13	2.54
North /Northwestern	0.10	1.80	-0.05	-0.83
Central / Black Sea	0.10	2.28	-0.02	-0.44
Volga/Viask/Volga Basin	0.13	2.92	-0.11	-2.57
North Caucas	-0.24	-5.20	-0.20	-4.23
Ural	0.11	2.49	-0.02	-0.43
Western Siberia	0.05	0.96	-0.06	-1.25
Eastern Siberia	<i>Omitted</i>		<i>Omitted</i>	
<i>Year dummies</i>				
1994	0.14	3.19	0.34	7.72
1995	0.10	2.15	0.23	4.84
1996	0.01	0.29	0.05	1.03
1998	<i>Omitted</i>		<i>Omitted</i>	
2000	0.02	0.46	0.10	2.26
2001	0.15	3.23	0.09	2.03
2002	0.18	3.76	0.17	3.63
2003	0.11	2.28	0.17	3.67
2004	0.15	3.20	0.26	5.39
# Observations	14 235		15 275	
log-likelihood	-8534.231		-8157.0404	

According to the parameter estimates, the typical number of weekly hours of work varies significantly between regions. In particular, women in the Moscow-St-Petersberg regions work fewer hours than those living in the Eastern Siberia region. According to the year dummy variables, women appear to have had a fairly stable workweek over the 1994-2004 period despite the major economic downturn of 1998. Men, on the other hand, have had shorter workweeks during that period but have since returned to their pre-crisis level.

Table 4  
Pooled Tobit Regressions: Weekly hours of Work

Variable	Wives		Husbands	
	Para.	T-stat	Para.	T-stat
<i>Individual characteristics</i>				
Intercept	-24.59	-6.07	29.42	8.50
Age	2.20	13.27	0.56	3.99
Age <sup>2</sup>	-0.02	-11.24	-0.01	-4.52
Schooling	1.52	3.88	0.53	1.59
Schooling <sup>2</sup>	-0.04	-3.08	-0.01	-0.85
<i>Region of residence</i>				
Moscow - St-Petersberg	-2.69	-3.30	-0.17	-0.22
North /Northwestern	0.86	0.94	-0.62	-0.71
Central / Black Sea	-0.10	-0.14	-1.90	-2.70
Volga/Viask/Volga Basin	1.51	2.06	-1.54	-2.18
North Caucas	-3.93	-4.95	-2.14	-2.82
Ural	-0.19	-0.26	-3.76	-5.20
Western Siberia	-0.97	-1.17	0.98	1.23
Eastern Siberia	<i>Omitted</i>		<i>Omitted</i>	
<i>Year dummies</i>				
1994	2.78	3.83	-0.22	-0.31
1995	0.95	1.18	2.70	3.47
1996	0.57	0.69	2.42	3.03
1998	<i>Omitted</i>		<i>Omitted</i>	
2000	1.05	1.38	2.10	2.80
2001	1.33	1.73	2.00	2.61
2002	1.41	1.83	2.25	2.97
2003	2.25	2.88	3.03	3.96
2004	1.26	1.61	2.14	2.81
$\sigma$	18.29	133.48	19.45	151.92
# Observations	10 017		11841	
log-likelihood	-41 126.77		-51 159.15	

All in all, the patterns depicted in Figure 1 are fairly robust. These show that the wives' wage rates have decreased significantly relative to their husbands' wage rates starting with the financial crisis of 1998. Yet despite this their participation rates and their workweek have remained relatively stable.<sup>7</sup> It

<sup>7</sup> The stability of the wage and participation equations has been investigated thor-

is thus likely that the wives' share of household income has decreased significantly over that period. Such important changes may very well impact the distribution of welfare within the households. Each year the RLMS investigates this issue in a qualitative manner. Spouses are asked to report their subjective "satisfaction level" with their economic conditions. Table 5 reports the figures for the years 2000 and 2004. Year 2000 coincides with the end of the economic downturn while 2004 corresponds to a period of relative growth. Responses are graduated from 1 to 5, with 1 corresponding to the highest level of satisfaction and 5 to the lowest. Interestingly, couples in our sample report being very unsatisfied with their economic conditions in the year 2000. Indeed, both spouses consistently report being "less than satisfied" or "Not at all satisfied". In 2004, by contrast, the majority of wives still report being unsatisfied while most husbands report being relatively satisfied.

Obviously, being satisfied or unsatisfied with one's economic conditions does not imply a gain or a loss of welfare. One may be unsatisfied with one's conditions but still benefit from intrahousehold transfers from his/her spouse. The regressions above and the available qualitative information nevertheless do suggest that spouses have had to adapt their behaviour to a changing economic environment. These changes inevitably influence intra-family relations and consequently the decision process. The behavioural adjustments may reflect not only gender-biased crisis effects, but also a new equilibrium bargaining power within households. Assuming Russian households behave in a Pareto-efficient manner, it is possible to investigate how the labour market adjustments affect the intra-household allocation of welfare.

### 3 Collective Model with Corner Solutions

As mentioned previously, changes in intrahousehold bargaining power can be ascertained from examining the labour market behaviour of both spouses as-

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oughly by Radtchenko (2006) based on regressions similar to those reported in Tables 2 and 3. She finds that the participation equations are stable over the 1994–1996 and 1998–2004 periods, but that the parameter estimates are distinct between the two periods. On the other hand, there does not appear to be any structural break in the wage equations of both husbands and wives.

Table 5  
Satisfaction Level with Economic Conditions<sup>†</sup>

2000							2004					
Husbands	Wives					Total	Wives					Total
	1	2	3	4	5		1	2	3	4	5	
<b>1</b>	3	6	5	7	4	25	4	7	9	9	4	33
<b>2</b>	5	57	18	38	21	139	9	117	67	102	2 606	2 901
<b>3</b>	5	47	73	84	43	252	6	58	110	165	89	428
<b>4</b>	7	59	102	344	172	684	12	74	117	375	227	805
<b>5</b>	4	29	56	198	2 860	3 147	8	37	44	174	250	513
<b>Total</b>	24	198	254	671	3 100	4 247	39	293	347	825	3 176	4 680

<sup>†</sup>The scale is constructed as follows: 1 – Fully satisfied, 2 – Rather satisfied, 3 – Mildly satisfied, 4 – Less than satisfied, 5 – Not at all satisfied.

suming the outcomes are Pareto-efficient.<sup>8</sup> In what follows, we describe a collective model that allows for corner solutions by both spouses [see Donni (2003), Bloemem (2008)]. The model is generalised to allow the sharing-rule to vary between the *pre* and the *post* 1998 period.<sup>9</sup>

### 3.1 The General Model

Consider a household composed of two individuals denoted  $j$  with  $j = f$  for female and  $j = m$  for male. We assume there are only two decision-makers, although we allow the presence of children and relatives (elderly).<sup>10</sup> Each

<sup>8</sup> See the aforementioned papers by Vermeulen, Cherchye, Rock and Sabbe who find support for the collective model using RLMS consumption data.

<sup>9</sup> We do not allow the sharing-rule to vary yearly to avoid over-parameterizing the model. Furthermore, we do not account for home production for two separate reasons. First, time-use data is no longer available as of round IX of the RLMS. Second, as shown by Donni (2004) and Chiappori (1997), if one is willing to assume that the home production function is additively separable, then the collective model is valid even if home production is not explicitly taken explicitly into account.

<sup>10</sup> The presence of elderly parents is frequent in Russian households. We acknowledge that elderly parents and grown-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 to avoid corner solutions. See Browning and Chiappori (1998), Chiappori and Ekeland (2006).

has his own standard utility function that depends on leisure (assignable and observed),  $L_j$ , and a Hicksian composite good (unobserved),  $C_j$ . Prices are normalized to 1. In the collective model, the decision process is assumed to yield Pareto-efficient solutions to the household resource allocation problem. Consumption is decentralized by the appropriate choice of full-income shares  $\Phi_j$  derived from the bargaining process.

The maximization program can thus be formulated as:<sup>11</sup>

$$\begin{aligned}
 & \underset{C_{jt}, h_{jt}}{\text{Max}} U_{jt}(h_{jt}, C_{jt}), j = f, m \text{ such that} & (1) \\
 & C_{ft} + w_{ft}L_{ft} \leq \Phi_{ft} \\
 & C_{mt} + w_{mt}L_{mt} \leq \Phi_{mt} \\
 & L_{jt} + h_{jt} = T, \\
 & \Phi_{ft} = \Phi_t(w_{ft}, w_{mt}, y_{ft}, y_{mt}, p_{ft}, p_{mt}) \\
 & \Phi_{mt} = w_{ft}T + w_{mt}T + y_{ft} + y_{mt} - \Phi_{ft},
 \end{aligned}$$

where  $t$  indicates the year,  $t = D$  corresponds to the financial crisis (year 1998),  $p_{jt}$  describes the participation statuses at time  $t$ ,  $w_{jt}$  are the hourly wage rates,  $h_{jt}$  are the labour supply functions, and  $y_{ft}$  and  $y_{mt}$  are female and male non-labour income.

The solution of the program yields:

$$\begin{aligned}
 h_{ft} &= h_t^f[w_{ft}, \Phi_{ft}(w_{ft}, w_{mt}, y_{ft}, y_{mt}, p_{ft}, p_{mt})] \\
 h_{mt} &= h_t^m[w_{mt}, \Phi_{mt}(w_{ft}, w_{mt}, y_{ft}, y_{mt}, p_{ft}, p_{mt})].
 \end{aligned}
 \tag{2}$$

To avoid addressing the issue of corner solutions, most empirical papers based on the collective model have so far limited their samples to working couples [see *e.g.* Chiappori et al. (2002)]. Donni (2003) proposes an innovative approach for taking into account corner solutions. He assumes that the household labour

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<sup>11</sup> We index the variables in the maximization problem by  $t$  to highlight the fact that we use panel data when estimating the model. We remove them in the remainder of the section to ease reading.

supply functions are continuous in the neighbourhood of a so-called participation frontier. Along this frontier each household member is indifferent to the participation status of his/her spouse. Donni (2003) shows that under this assumption both the preferences and the sharing rule are identified up to a constant as in Chiappori(1988, 1992).

To fix ideas, let

$$\omega^j(w_f, w_m, y) \equiv \frac{U_H^j(T, C_j(w_f, w_m, y))}{U_C^j(T, C_j(w_f, w_m, y))}$$

be the reservation wage of spouse  $j$ , where  $U_H^j$  and  $U_C^j$  are the partial derivatives of the utility function with respect to working hours and consumption, and  $y$  is the total household non-labour income. This function describes the marginal rate of substitution between leisure and consumption calculated at  $L = 0$  ( $H = T$ ). Thus the reservation wage of spouse  $j$  is implicitly defined as a function of non-labour income and his or her partner's wage. In order to guarantee the uniqueness of the reservation wages, Donni (2003) assumes that the preferences and the sharing rule are such that for each  $(w_f^*, w_m^*, y)$  and  $(w_f', w_m', y)$  the following condition holds:

$$\max_{j=f,m} \left( \left| \omega^j(w_f^*, w_m^*, y) - \omega^j(w_f', w_m', y) \right| \right) \leq \max_{j=f,m} \left( |w_j^* - w_j'| \right). \quad (3)$$

This condition is implicitly equivalent to assuming that the wage effects on the shares of each spouse not be “too large”.<sup>12</sup> The condition in (3) implies two important results [Donni (2003), Blundell, Chiappori, Magnac and Meghir (2007)]. First, the mapping between  $[\omega^m(\cdot), \omega^f(\cdot)]$  and  $(w_f, w_m)$  is unique. There thus exists a single pair of wages such that both spouses are indifferent between working or not. Second, for each spouse  $j$ , there exists a function  $\gamma^j(w_s, y)$  that completely characterizes participation:

$$p_j = \begin{cases} 1 & \text{if and only if } w_j > \gamma^j(w_s, y) \\ 0 & \text{if and only if } w_j \leq \gamma^j(w_s, y), \quad j, s = f, m, j \neq s. \end{cases} \quad (4)$$

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<sup>12</sup> The work of Kalugina, Radtchenko and Sofer (2007) and Radtchenko (2006) provide some support for this assumption.

The intuition behind this result is the following. In the case where both husband and wife work, the first and second order derivatives of the labour supply functions in (2) generate a set of partial differential equations that can be solved to identify the sharing-rule up to an additive constant. Donni (2003) has shown that if only one spouse works, then the set of partial differential equations is also satisfied as  $w_i \rightarrow \gamma^j(\cdot)$ . Thus the participation frontier,  $\gamma^j(\cdot)$ , serves as a boundary condition for the system of differential equations.

### 3.2 The Labour Supply Model

Let  $c_D = (\alpha_{mD}, \alpha_{fD}, \beta_{mD}, \beta_{fD}, \gamma_{mD}, \gamma_{fD}, q_{mD}, q_{fD}, q_{fmD})$  be the vector of “structural” parameters. Let  $D$  index the structural parameters before ( $D = 0$ ) and after the 1998 crisis ( $D = 1$ ). Thus  $c_D = c_0 + c_1D$  with  $c_0 = (\alpha_{m0}, \alpha_{f0}, \beta_{m0}, \beta_{f0}, \gamma_{m0}, \gamma_{f0}, q_{m0}, q_{f0}, q_{fm0})$  and  $c_1 = (\alpha_{m1}, \alpha_{f1}, \beta_{m1}, \beta_{f1}, \gamma_{m1}, \gamma_{f1}, q_{m1}, q_{f1}, q_{fm1})$ . Male and female individual characteristics are denoted  $X_m$  and  $X_f$  while household characteristics are denoted  $X_{fm}$ .

The labour supply functions are assumed log-linear, *i.e.*

$$h_m^* = \alpha_{mD} \ln(w_m) + \beta_{mD} \ln(w_m)^2 + \gamma_{mD} \ln(\Phi_m) + q_{mD} \quad (5)$$

$$h_f^* = \alpha_{fD} \ln(w_f) + \beta_{fD} \ln(w_f)^2 + \gamma_{fD} \ln(\Phi_f) + q_{fD}, \quad (6)$$

where  $q_{mD}$  and  $q_{fD}$  include individual and household characteristics, *i.e.*

$$q_{mD} = m_D X_m + q_{fmD} X_{(fm)} + c_{mD}$$

$$q_{fD} = f_D X_m + q_{fmD} X_{(fm)} + c_{fD}.$$

Denote  $\Delta = \Phi_m - \Phi_f$ . Given the budget constraint  $\Phi = \Phi_f + \Phi_m$ , the individual shares can be written as:

$$\Phi_m = \frac{\Phi + \Delta}{2} \quad \Phi_f = \frac{\Phi - \Delta}{2}.$$

Thus in log form

$$\ln(\Phi_m) = \ln\left(\frac{\Phi + \Delta}{2}\right) = \ln\left(\Phi\left(1 + \frac{\Delta}{\Phi}\right)/2\right) \quad (7)$$

$$\ln(\Phi_f) = \ln\left(\frac{\Phi - \Delta}{2}\right) = \ln\left(\Phi\left(1 - \frac{\Delta}{\Phi}\right)/2\right). \quad (8)$$

Let  $d = \frac{\Delta}{\Phi}$ . The results of Kalugina et al. (2007) and Radtchenko (2007) show that in the RLMS data the shares of two household members are usually of the same order. Consequently  $d$  is likely relatively small and by Taylor expansion we get

$$\begin{aligned} \ln(\Phi_m) &= \ln(\Phi) + \ln(1 + d) - \ln(0.5) \approx \ln(\Phi) + d - \ln(0.5) \\ \ln(\Phi_f) &= \ln(\Phi) + \ln(1 - d) - \ln(0.5) \approx \ln(\Phi) - d - \ln(0.5). \end{aligned} \quad (9)$$

The individual shares  $\Phi_m$  and  $\Phi_f$  are defined by (7) and (8) in terms of  $\Phi = (w_m + w_f)T + y$ , and  $d$  which we specify below. Substituting (9) into (7) and (8) the labour supply functions become<sup>13</sup>

$$\begin{aligned} h_m^* &= \alpha_{mD} \ln(w_m) + \beta_{mD} \ln(w_m)^2 + \gamma_{mD}(\ln(\Phi) + d) + q_{mD} \\ h_f^* &= \alpha_{fD} \ln(w_f) + \beta_{fD} \ln(w_f)^2 + \gamma_{fD}(\ln(\Phi) - d) + q_{fD} \end{aligned} \quad (10)$$

### 3.3 Introducing Non-Participation

The continuity condition on the participation frontier applies to the labour supply functions as well as the sharing rule. Indeed, the latter is intimately related to the participation status of both spouses. Thus, given our specification of the sharing rule, the continuity condition hinges upon  $d$  in (10) being continuous as each spouse's labour supply tends to zero. The following trans-

<sup>13</sup> The constant terms  $q_{mD}$  and  $q_{fD}$  include  $(-\ln(0.5))$ .

formation of  $d$  insures continuity along the participation frontier:

$$d^* = \begin{cases} d + rh_f^*, & \text{if } p_m = 1 \text{ and } p_f = 0 \\ d + Rh_m^*, & \text{if } p_f = 1 \text{ and } p_m = 0, \end{cases} \quad (11)$$

where  $r$  and  $R$  are the parameters describing the continuity of the sharing rule derivatives on the participation frontier. When one's spouse is not working, the labour supply functions become (upon substituting  $d^*$  and regrouping terms):

$$\begin{aligned} h_m &= \alpha_{mD} \ln(w_{mt}) + \beta_{mD} \ln(w_m)^2 + \gamma_{mD}(\ln(\Phi) + d) + sh_f^* + q_{mD}, \text{ with } p_{ft} = 0 \\ h_f &= \alpha_{fD} \ln(w_{ft}) + \beta_{fD} \ln(w_f)^2 + \gamma_{fD}(\ln(\Phi) - d) + Sh_m^* + q_{fD}, \text{ with } p_{mt} = 0, \end{aligned}$$

where  $S$  and  $s$  are the parameters that insure the continuity of the labour supply functions. The parameters  $r$  and  $R$  are related to  $s$  and  $S$  through the following constraints:  $r = s/\gamma_{mD}$ ,  $R = -S/\gamma_{fD}$ . The complete structural collective model of household labour supply with corner solutions can be formulated as follows:

$$h_m = \begin{cases} \alpha_{mD} \ln(w_m) + \beta_{mD} \ln(w_m)^2 + \gamma_{mD}(\ln(\Phi) + d) + q_{mD}, & \text{if } p_f = 1 \\ \alpha_{mD} \ln(w_m) + \beta_{mD} \ln(w_m)^2 + \gamma_{mD}(\ln(\Phi) + d) + q_{mD} + \\ \quad s (\alpha_{fD} \ln(w_f) + \beta_{fD} \ln(w_f)^2 + \gamma_{fD}(\ln(\Phi) - d) + q_{fD}), & \text{if } p_f = 0 \end{cases} \quad (12)$$

$$h_f = \begin{cases} \alpha_{fD} \ln(w_f) + \beta_{fD} \ln(w_f)^2 + \gamma_{fD}(\ln(\Phi) - d) + q_{fD}, & \text{if } p_m = 1 \\ \alpha_{fD} \ln(w_f) + \beta_{fD} \ln(w_f)^2 + \gamma_{fD}(\ln(\Phi) - d) + q_{fD} + \\ \quad S (\alpha_{mD} \ln(w_m) + \beta_{mD} \ln(w_m)^2 + \gamma_{mD}(\ln(\Phi) + d) + q_{mD}), & \text{if } p_m = 0 \end{cases} \quad (13)$$

As with any endogenous tobit model, the issue of coherency must be addressed [see Gourieroux (1980), Lacroix and Fortin (1992) and Fortin, Lacroix and Villeval (2007)]. It can easily be shown that the coherency condition in our model boils down to [see also Bloemem (2008)]:  $|sS| < 1$ . This condition needs to be verified once the model is estimated.

### 3.4 Sharing Rule Specification and Reduced-Form Model

Individual income shares are not observed in the data. Consequently, the sharing-rule in (9) must be specified explicitly. Let  $d$  be made to depend upon the log-wages  $[\ln(w_m), \ln(w_f), \ln(w_m)^2, \ln(w_f)^2]$ , and individual and household characteristics  $(X_f, X_m, X_{fm})$ :

$$d = \theta X,$$

where  $X = [\ln(w_m), \ln(w_f), \ln(w_m)^2, \ln(w_f)^2, X_m, X_f, X_{fm}, 1]$  and  $\theta = (\theta_{wm}, \theta_{wf}, \theta_{w2m}, \theta_{w2f}, \theta_m, \theta_f, \theta_{fm}, \theta_0)$  is the vector of corresponding coefficients, including a constant,  $\theta_0$  (we omit indexing the parameters by  $D$  to ease reading). By substituting  $d$  in the labour supply functions (12) we get:

$$h_m^* = \alpha_m \ln(w_m) + \beta_m \ln(w_m)^2 + \quad (14)$$

$$\begin{aligned} & \gamma_m \left[ \ln(\Phi) + \theta_{wm} \ln(w_m) + \theta_{wf} \ln(w_f) + \theta_{w2m} \ln(w_m)^2 + \theta_{w2f} \ln(w_f)^2 + \right. \\ & \quad \left. \theta_m X_m + \theta_f X_f + \theta_{fm} X_{fm} + \theta_0 \right] + \\ & m X_m + m_{fm} X_{fm} + c_m \end{aligned}$$

$$h_f^* = \alpha_f \ln(w_f) + \beta_f \ln(w_f)^2 + \quad (15)$$

$$\begin{aligned} & \gamma_f \left[ (\ln(\Phi) - \theta_{wm} \ln(w_m) - \theta_{wf} \ln(w_f) - \theta_{w2m} \ln(w_m)^2 - \theta_{w2f} \ln(w_f)^2 - \right. \\ & \quad \left. \theta_m X_m - \theta_f X_f - \theta_{fm} X_{fm} - \theta_0) \right] + \\ & f X_f + f_{fm} X_{fm} + c_f \end{aligned}$$

with

$$h_m = \begin{cases} h_m^*, & \text{if } p_f = 1 \\ h_m^* + s \cdot h_f^*, & \text{if } p_f = 0 \end{cases} \quad (16)$$

$$h_f = \begin{cases} h_f^*, & \text{if } p_m = 1 \\ h_f^* + S \cdot h_m^*, & \text{if } p_m = 0 \end{cases} \quad (17)$$

In their reduced-form, equations (15) and (16) are given by:

$$h_m^* = a_1 \ln(w_m) + a_2 \ln(w_f) + a_3 \ln(w_m)^2 + a_4 \ln(w_f)^2 + a_5 \ln(\Phi) + \quad (18)$$

$$\begin{aligned}
& a_6 X_m + a_7 X_f + a_8 X_{fm} + a_0 \\
h_f^* = & b_1 \ln(w_m) + b_2 \ln(w_f) + b_3 \ln(w_h)^2 + b_4 \ln(w_f)^2 + b_5 \ln(\Phi) + \\
& b_6 X_m + b_7 X_f + b_8 X_{fm} + b_0.
\end{aligned} \tag{19}$$

The structural parameters corresponding to the wage rates, the sharing-rule and individual characteristics are all identified [see equations (5) and (6)]:

Husbands	Wives
$\alpha_m = a_1 + a_5 b_1 / b_5$	$\alpha_f = b_1 + b_5 a_2 / a_5$
$\beta_m = a_3 + a_5 b_3 / b_5$	$\beta_f = b_4 + b_5 a_4 / a_5$
$\gamma_m = a_5$	$\gamma_f = b_5$
$m = a_6 + a_5 b_6 / b_5$	$f = b_7 + b_5 a_7 / a_5$
$\theta_m = -b_6 / a_5$	$\theta_f = a_7 / a_5$
$\theta_{wm} = -b_1 / b_5$	$\theta_{wf} = a_2 / a_5$
$\theta_{w2m} = -b_3 / b_5$	$\theta_{w2f} = a_4 / a_5$
$r = s / a_5$	$R = -S / b_5.$

The marginal effects of the variables  $X_m$  and  $X_f$  on the sharing rule are given by the parameters  $\theta_m$  and  $-\theta_f$ . The direct effects of the linear and quadratic wage terms and the variables  $X_m$  and  $X_f$  on the spouses' labour supply are given by  $\theta_{wm}, \theta_{w2m}, \alpha_m, \beta_m, m$  and  $\theta_{wf}, \theta_{w2f}, \alpha_m, \beta_f, f$ , respectively.

The three constants of the structural model ( $\theta_0, c_{mD}, c_{fD}$ ) are not identified, nor are the parameters corresponding to the household characteristics  $\theta_{fm}, m_{fmD}, f_{fmD}$ . In the latter case, the identification problem stems from the fact that the household characteristics are determinants of the labour supply of both spouses as well as the sharing rule. On the other hand, the identified parameters allow us to compute the elasticities of the sharing rule with respect to the wage rates:

$$\frac{\partial \ln \Phi_m}{\partial \ln w_j} = \frac{\partial \ln \Phi}{\partial \ln w_j} + \frac{\partial d}{\partial \ln w_j} = T \frac{w_j}{\Phi} + \theta_{w_j} + \theta_{w_{2j}} \quad (20)$$

$$\frac{\partial \ln \Phi_f}{\partial \ln w_j} = \frac{\partial \ln \Phi}{\partial \ln w_j} - \frac{\partial d}{\partial \ln w_j} = T \frac{w_j}{\Phi} - \theta_{w_j} - \theta_{w_{2j}}. \quad (21)$$

Because individual shares  $\Phi_m$  and  $\Phi_f$  are neither observed nor measured, the marginal effects can only be calculated for arbitrary values of the household income sharing, for example at half of the total income:

$$\frac{\partial \Phi_m}{\partial w_j} \Big|_{\Phi_m = \Phi_f} = T \frac{\Phi_m}{\Phi} + (\theta_{w_j} + \theta_{2w_j}) \frac{\Phi_m}{w_j} = \frac{1}{2} \left( T + (\theta_{w_j} + \theta_{2w_j}) \frac{\Phi}{w_j} \right) \quad (22)$$

$$\frac{\partial \Phi_f}{\partial w_j} \Big|_{\Phi_m = \Phi_f} = T \frac{\Phi_f}{\Phi} - (\theta_{w_j} + \theta_{2w_j}) \frac{\Phi_f}{w_j} = \frac{1}{2} \left( T - (\theta_{w_j} + \theta_{2w_j}) \frac{\Phi}{w_j} \right). \quad (23)$$

#### 4 The Statistical Model

The model of the previous section focused entirely on the labour supply. In particular, it assumes that wage rates are observed even in the event a spouse is not working. We must thus specify a wage function for spouse  $j$  at time  $t$ .<sup>14</sup>

$$\ln w_{jt} = z_{jt} \eta_j + \delta_j D_j + \pi_j + u_{jt}, \quad (24)$$

where

$$D = \begin{cases} 1, & \text{if } t \geq 1998 \\ 0, & \text{if } t < 1998. \end{cases} \quad (25)$$

The equation states that the wage rates depend upon observed characteristics,  $z_{jt}$ , as well as time-invariant unobserved characteristics,  $\pi_j$ , and a contempora-

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<sup>14</sup> We index the variables with  $t$  to underline the fact that the model is estimated with panel data.

neous shock,  $u_{jt}$ . We also allow the wage function to shift in a discrete manner between the pre and post 1998 periods through the parameter  $\delta_j$ .

Let  $x_{jt}$  be the vector of individual characteristics of the household member  $j$  that proxies his/her preferences and which may also affect the sharing rule. Furthermore, let  $\nu_{jt}$  and  $\lambda_j$  represent unobserved heterogeneity variables that are time-dependent and time-independent, respectively. The reduced-form labour supply model can then be written as:

$$\begin{aligned}
p_{jt} &= \mathbb{I}(h_{jt}^* > 0) \\
h_{mt}^* &= a_D x_{mt} + \nu_{mt} + \lambda_m + (1 - p_{ft})s \cdot (b_D x_{ft} + \nu_{ft} + \lambda_f) \\
h_{ft}^* &= b_D x_{ft} + \nu_{ft} + \lambda_f + (1 - p_{mt})S \cdot (a_D x_{mt} + \nu_{mt} + \lambda_m) \\
h_{jt} &= \begin{cases} h_{jt}^* & \text{if } h_{jt}^* \geq 0, j = f, m \\ 0 & \text{otherwise,} \end{cases}
\end{aligned} \tag{26}$$

where  $a_D$  and  $b_D$  are the parameter vectors of the reduced forms (18) and (19), respectively.<sup>15</sup>

The contemporaneous error terms  $(u_{mt}, u_{ft}, \nu_{mt}, \nu_{ft})$  of the wage and labour supply equations are assumed to have a joint normal distribution with mean 0 and covariance matrix  $\Sigma_{uv}$ :

$$\Sigma_{uv} = \begin{pmatrix} \sigma_1^2 & \sigma_{12} & \sigma_{13} & 0 \\ \sigma_{12} & \sigma_2^2 & 0 & \sigma_{24} \\ \sigma_{13} & 0 & \sigma_3^2 & \sigma_{34} \\ 0 & \sigma_{24} & \sigma_{34} & \sigma_4^2 \end{pmatrix} \tag{27}$$

The error terms are thus assumed to be independent across households. As in Bloemem (2008), we allow nonzero correlations between spouses' labour supply and wage equations. Each spouse's labour supply function is further

<sup>15</sup> Additive heterogeneity can be shown not to affect the identification of the sharing-rule since the additive constant is not identified. See our remark relative to the unidentified parameters on page 19.

assumed to be correlated to his/her wage function. The zeros on the diagonal reflect the fact that we do not allow the wage rate and the hours of work to be correlated across spouses. Consequently, the covariance matrix of error terms of the wage and labour supply equations in (26) is given by:

$$\Sigma_{Ss} = \begin{pmatrix} \sigma_1^2 + s^{*2} \sigma_2^2 + 2s^* \sigma_{12} & (1 + S^* s^*) \sigma_{12} + S^* \sigma_1^2 + s^* \sigma_2^2 & \sigma_{13} & 0 \\ (1 + S^* s^*) \sigma_{12} + S^* \sigma_1^2 + s^* \sigma_2^2 & \sigma_2^2 + S^{*2} \sigma_1^2 + 2S^* \sigma_{12} & 0 & \sigma_{24} \\ \sigma_{13} & 0 & \sigma_3^2 & \sigma_{34} \\ 0 & \sigma_{24} & \sigma_{34} & \sigma_4^2 \end{pmatrix},$$

with  $S^* = S(1 - p_{mt})$ ,  $s^* = s(1 - p_{ft})$  and  $p_{jt} = \mathbb{I}(h_{jt}^* > 0)$ . It should be noted that  $S^*$  and  $s^*$  take zero or non zero values depending on the participation status of both partners. Thus, the covariance matrix differs according to the four possible participation regimes (both partners work, one works, none work).

The contemporaneous error terms  $(u_{mt}, u_{ft}, \nu_{mt}, \nu_{ft})$  are assumed to be independent of the individual random effects  $(\pi_f, \pi_m, \lambda_f, \lambda_m)$ . Following Hoynes (1996), and in the spirit of Heckman and Singer (1984), we assume that the individual random effects follow a discrete distribution with a finite number of realizations.<sup>16</sup> More precisely, we assume that the terms  $(\pi_m^k, \lambda_m^k, \pi_f^{k'}, \lambda_f^{k'})$  occur with probability  $p^{k,k'}$ ,  $k, k' = 1, \dots, K$ . There are thus  $K \times K$  possible types of household configuration in the model.

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<sup>16</sup> We could in principle specify a standard random effects model. To be worthwhile, such a specification would allow the random terms to be correlated across years. Unfortunately, over half of our sample is only observed once (1040 out of 1953 households). We could also impose the random effects to be constant across years as in Bloemem (2008). We deem preferable to use a parsimonious non-parametric specification thus avoiding to turn to specific parametric distributions. Michaud and Vermeulen (2006) have recently estimated a discrete-choice collective household labour supply model in which unobserved heterogeneity is modelled in a similar fashion.

#### 4.1 Likelihood Function

The complete model is defined by equations (24), (26) and (27). Because the covariance matrix (27) is positive definite, it can be decomposed as follows:

$$\Sigma_{uv} = LL',$$

where  $L$  is a lower triangular (Cholesky) matrix. The constraints  $\sigma_{14} = 0$  and  $\sigma_{23} = 0$  in  $\Sigma_{uv}$  translate into constraints on the parameters of the matrix  $L$ . Indeed, since  $\sigma_{14} = l_{11}l_{41}$  and  $\sigma_{23} = l_{21}l_{31} + l_{22}l_{32}$ , it follows that  $l_{41} = 0$  and  $l_{32} = -l_{21}l_{31}/l_{22}$ .

Naturally, we do not observe a wage rate for individuals who do not work. We must therefore integrate over the whole domain to complete the likelihood function. The conditional likelihood function is given by:

$$\begin{aligned} L(\cdot; \pi_m^k, \pi_f^{k'}, \lambda_m^k, \lambda_f^{k'}) = & \prod_{\substack{p_{ft}=1 \\ p_{mt}=1}} f_4(u_{mt}, u_{ft}, \nu_{mt}, \nu_{ft}; \pi_m^k, \pi_f^{k'}, \lambda_m^k, \lambda_f^{k'}) \times \\ & \prod_{\substack{p_{ft}=1 \\ p_{mt}=0}} \int_{-\infty}^{-(a_D x_{mt} + \lambda_m)} f_3(u_{mt}, \nu_{mt}, \nu_{ft} + S\nu_{mt}; \pi_m^k, \pi_f^{k'}, \lambda_m^k, \lambda_f^{k'}) d\nu_{mt} \times \\ & \prod_{\substack{p_{ft}=0 \\ p_{mt}=1}} \int_{-\infty}^{-(b_D x_{ft} + \lambda_f)} f_3(u_{mt}, \nu_{ft}, \nu_{mt} + s\nu_{ft}; \pi_m^k, \pi_f^{k'}, \lambda_m^k, \lambda_f^{k'}) d\nu_{ft} \times \\ & \prod_{\substack{p_{ft}=0 \\ p_{mt}=0}} \int_{-\infty}^{b_m} \int_{-\infty}^{b_f} f_2(\nu_{mt} + s\nu_{ft}, \nu_{ft} + S\nu_{mt}; \pi_m^k, \pi_f^{k'}, \lambda_m^k, \lambda_f^{k'}) d(\nu_{mt} + s\nu_{ft}) d(\nu_{ft} + S\nu_{mt}) \end{aligned}$$

where the bounds  $b_m, b_f$  are defined as

$$\begin{aligned} b_m &= -(a_D x_{imt} + \lambda_{im} + s \cdot (b_D x_{ift} + \lambda_{if})) \\ b_f &= -(b_D x_{ift} + \lambda_{if} + S \cdot (a_D x_{imt} + \lambda_{im})), \end{aligned}$$

and where  $f_r$  is the normal density function of dimension  $r$ . The unconditional likelihood function is obtained by summing over the unobserved heterogeneity components:

$$L = \sum_{k=1}^K \sum_{k'=1}^K p^{k,k'} L(\cdot; \pi_m^k, \pi_f^{k'}, \lambda_m^k, \lambda_f^{k'})$$

## 5 Results

### 5.1 *Reduced-Form Parameters*

The parameter estimates of the reduced-form model [equations (18) and (19)] are presented in Tables 6–10. Table 6 focuses on the labour supply functions. For each spouse, the parameter estimates are divided into two columns according to whether  $D = 0$  or  $D = 1$ . In general, the full-income variable has a negative impact on labour supply, but is statistically significant only in the husbands' equation in the post-1998 period. An increase in the husbands' wage rate has a negative impact on their own labour supply in the pre-1998 period, but a positive one in the post-1998 period, and no effect on the wives' labour supply. The wives' wage rates, on the other hand, have no effect on either labour supplies in both periods.

The second panel of the table reports the parameters estimates associated with  $X_m, X_f, X_{fm}$ , respectively. According to the table, schooling has a positive effect on weekly hours of work of both husbands and wives, and pre-schoolers exert a negative impact on husbands' hours of work. There are no statistical differences between the pre and the post 1998 periods. The dummy variable Post-1998 indicates that both husbands and wives have increased their labour supply following the financial crisis of 1998. The parameter estimate aggregates changes at the intensive and extensive margins, but is nevertheless consistent with the results of Table 4 and the evidence presented in Figure 1.

The parameter estimates of the wage equations are reported in Table 7.<sup>17</sup>

<sup>17</sup>The wage equations include regional dummy variables that are absent from the hours equations. This exclusion restriction is motivated by the fact that auxiliary regressions has shown that once we condition on wages, there is little regional vari-

The table shows that the wage rates decrease slightly with age and increase by approximately 4% with an additional year of schooling. Such a rate of return is certainly low by Western standards. Yet they coincide perfectly with those reported in Cheidvaaser and Benitez-Silva (2007).<sup>18</sup> The table also shows that wages vary considerably across regions for both husbands and wives. Not surprisingly, wages are highest in the Moscow-St-Petersberg regions, and lowest in the Volga and North Caucuses regions. The dummy variable  $D$  captures any shift that may have occurred in the wage functions in the post-1998 period above and beyond those that are already controlled for in the regression. It shows that both husbands and wives have benefited from increases of 11% and 5%, respectively. This is consistent with the results reported in Table 2 that indicated that the husbands/wives wage ratios were increasing. Indeed, the results presented in Table 2 were based on households in which both spouses are working. In Table 7, on the other hand, the estimation includes husbands and wives whose spouses do not work. It is thus conceivable that wives whose husbands do not work are a self-selected group whose earnings are larger than the average.<sup>19</sup>

Recall from equation (26) that both the labour supply equations and the wage equations contain random effects and correlated error terms. The parameters of the unobserved heterogeneity are presented in Table 8. The first two lines of the table relate to the labour supply functions.<sup>20</sup> According to the parameter estimates, type 1 husbands have a stronger preference for work than

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ation in weekly hours of work. On the other hand, children variables are included in the hours regressions but not in the wage regressions.

<sup>18</sup> The low rate of return was traditionally attributed to government “wage-squeezing” policies. It was conjectured that the rate of return would increase as Russia moved towards market democracy [see Brainerd (1998)]. Cheidvaaser and Benitez-Silva (2007) attribute the low rate of return to education in post-communist Russia to an excess supply of well-educated workers.

<sup>19</sup> One could also argue the opposite: wives with inactive husbands are willing to work at lower than average wage rates. While plausible, this situation is more likely when husbands are involuntarily unemployed. In principle, there are no involuntarily unemployed individuals in our sample.

<sup>20</sup> The model is estimated with only two pairs  $(\pi_j^k, \lambda_j^k)$ . The data support up to three pairs of parameters. Unfortunately, one of the pairs always has a very small probability of realization. To avoid over-parameterizing the model, we focus on the more parsimonious specification.

type 2 while the converse holds for wives. The next two lines of the table report the unobserved heterogeneity components of the wage equations. While every parameter estimates are statistically significant, the null assumptions  $H_0 : \omega_m^1 = \omega_m^2$  and  $H_0 : \omega_f^1 = \omega_f^2$  can not be rejected. Thus contrary to the labour supply functions, unobserved heterogeneity appear not to be an important factor in determining the wage rates of husbands and wives. Recall that there are potentially four types of households in the data. Table 9 reports the distribution of household types. By far the most common type corresponds to  $(\lambda_m^2, \lambda_f^2)$  and  $(\omega_m^2, \omega_f^2)$ . Other configurations occur with much smaller probabilities (1.4%, 4.2% and 6.8%). One can thus conjecture that the control variables are capturing a sizeable amount of individual heterogeneity so that there is little room for unobserved heterogeneity parameters.

Finally, we report the parameter estimates of the covariance matrix (27) in Table 10. The matrix  $\Sigma_{uv}$  captures the covariances between the contemporaneous error terms of the wage and labour supply equations. The estimates indicate that the spouses' wage rates are very weakly correlated with their own labour supply ( $\sigma_{u_m \nu_m} = 0.008$  and  $\sigma_{u_f \nu_f} = -0.007$ ) and between themselves ( $\sigma_{u_m u_f} = 0.011$ ). On the other hand, their labour supply functions are strongly correlated ( $\sigma_{\nu_m \nu_f} = 0.330$ ). Taken as a whole, the parameter estimates of the unobserved heterogeneity suggest that the households in our sample are relatively homogeneous (only one important type) and that there is little selection into employment that may be linked to unobservable characteristics that simultaneously affect the wages and the hours of work. On the other hand, unobserved shocks that may increase (or decrease) participation of both spouses are strongly correlated. This suggests that factors that are not controlled for in the hours equations affect spouses in a similar fashion.

## 5.2 Structural Parameters

The parameters of the structural model [equations (12) and (13)] are reported in Tables 11. As in Kalugina et al. (2007) and Radtchenko (2007), we find a negative relationship between own wage and labour supply ( $\alpha_{fD} < 0$ ,  $\alpha_{mD} < 0$ ). The negative relation between hours and wages is possibly due to the fact that the latter are very low and the hours of work relatively high that the

income effect dominates the substitution effect.<sup>21</sup> The parameter estimates of  $\gamma_{fD}$  and  $\gamma_{mD}$  are negative and statistically significant in the post-1998 period which suggests leisure is a normal good. The table also reports the parameters associated with the wage rates in the sharing-rule. Finally, the labour supply continuity parameters  $S$  and  $s$  easily verify the coherency condition of the model (*i.e.*  $|sS| < 1$ ). We comment below on the interpretation of the labour supply and sharing-rule continuity parameters.

From the parameters of Table 11, a number of interesting statistics can be computed.<sup>22</sup> First, recall from equations (20) and (21) that the elasticity of each spouse's share on income can be computed with respect to both wages rates. These are reported in the top panel of Table 12. Bearing in mind that not all are statistically significant, the table nevertheless reveals interesting changes between the pre and post 1998 periods. To start with, a ten percentage point increase in husbands' wage rates increases their relative income share way more in the aftermath of the financial crisis. According to the table, such a change would have translated into a 5.2% increase before 1998 and by as much as 9.2% after 1998. The same wage increase would have increased the wives' share by 3.3% and 0.9%, respectively. This means that as the husbands' wage rates increased in the years that followed the economic downfall, they have kept a greater share of the additional full income to themselves. Wives, on the other hand, have behaved differently. The table shows that a 10 percentage point increase in their wages translated into a 7.8% increase of their share prior to 1998 and approximately 6.6% after 1998. Thus while both husbands and wives do behave altruistically, wives in the post-crisis period seem to transfer a greater share of family full-income than husbands do, contrary to what prevailed in the pre-crisis period.

The next panel of the table presents the impact of a unit increase in each

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<sup>21</sup> Active husbands and wives in our sample work on average 44 and 40 hours per week, respectively.

<sup>22</sup> Most of these are highly non-linear functions of the structural parameters. So while few of these are individually statistically significant, it may be the case that these non-linear functions turn out to be significant once the covariance between the parameter estimates are taken into account. Furthermore, the elasticities in Table 12 are intimately related to the parameters of the sharing-rule, *i.e.*  $\gamma_{mD}$  and  $\gamma_{fD}$ . Unfortunately, non-labour or full-income parameters are rarely statistically significant [see *e.g.* Fortin and Lacroix (1997)].

spouse's wage rate on their relative full-income assuming it is initially divided into equal shares. The calculations are based upon equations (22) and (23). These results are central to the paper but their validity depends on the assumption of equal sharing holding true. A unit increase in the hourly wage rate of a spouse automatically increases full-income by 168\$ ( $T = 168$  hours per week). The table indicates that, prior to 1998, an increase in the husbands' wage rates would have increased their share of the full-income by 102.73\$ and that of their wives by 65.27\$. In the post 1998 period, an identical change in their wage rates would have increased their share by 152.12\$ and that of the wives by only 15.87\$. The marginal impact of an increase in wives' hourly wage rates is completely different. Indeed, prior to 1998 they would have kept nearly all the increase in the family full-income to themselves (167.49\$). In the post 1998 period, they would have kept 125.98\$ to themselves and transferred 42.02\$ to their husbands. What these estimates suggest is that spouses do not behave in an egotistic manner. An increase in their wage rates do increase their share of the household income but not at the expense of their spouse. Both benefit from the additional income. The estimates do suggest, however, that in the post 1998 period, as the economic environment got better, husbands became somewhat more egotistic and wives somewhat more altruistic.

The behavioural changes relative to the full-income sharing is bound to impact the labour supply elasticities. To investigate this, we report two different types of elasticities in Table 13. The top panel reports the own-wage elasticities computed under the assumption that the sharing-rule is unaffected by the increase in the wage rate.<sup>23</sup> The elasticities reported in the bottom panel account for the additional income effects accruing from changes in the sharing of the full-income. The results of the top panel indicate the elasticities are relatively constant across periods for both husbands and wives. Once again the results relative to the husbands are relatively more precise. The bottom panel tells a different story. First, the impact of a marginal increase in the husbands' wage rates on their labour supply increases from -0.05 to -0.20 between the pre and post crisis periods. This is essentially due to the fact that husbands transfer less income to their spouse in the post-1998 period. Likewise, an increase in the wives' wage rates has a negative impact on their husbands' labour supply in the post-1998 period. This is a consequence of transferring them more income than was previously the case. As a matter of fact, the estimates suggest that

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<sup>23</sup> Recall that the spouse's wage rate intervene only through the sharing-rule.

in the pre-1998 period (bottom line) wife's wage rates had no impact on their husbands labour supply precisely because they essentially kept the additional full-income to themselves. Finally, the table shows that the wives labour supply elasticities are generally negative (although not statistically significant) once the sharing-rule is accounted for. This follows from the fact that an increase in their own wage rate, or that of their husbands, translates into an increase in their full-income.

The above elasticities are derived under the assumption that both spouses work. Recall from equations (11), (12) and (13) that the labour supply functions and the sharing-rule change according to the participation status of each spouse. The continuity parameters are presented in Table 11. The labor supply continuity parameters  $S$  and  $s$  insure the statistical coherency of the model with four participation regimes but also underline the importance of taking into account the participation status of each spouse on the own-wage elasticity of their labour supply. For example, given that husbands have a negative own-wage elasticity and wives have a negative own-share elasticity, a positive value of  $s$  implies that if wives stop working then the elasticity of husbands' labour supply with respect to their wage will increase. This effect occurs via income transfers from husbands to their wives. The same reasoning applies, *mutatis mutandis* to wives through the parameter  $S$ . Likewise, a change in the participation status of one of the spouse in the post-1998 crisis influences the manner in which the household full-income is distributed. For example, given that husbands have a negative own-wage elasticity, a positive value of  $R$  implies that if they were to stop working then the elasticity of their income share with respect to their own wage would decrease [see equation (11)]. Likewise, because  $r < 0$  if wives were to stop working their elasticity would also decrease. These results highlight the importance of taking into account the participation status of each spouse because the intra-household income distribution is intimately related to it.

## 6 CONCLUSION

This paper investigates the evolution of the intra-household income allocation among Russian households over a period of significant economic turmoil. The main thrust behind the paper is the recognition that the important changes

in the economic and institutional environment that have occurred in Russia over the 1994–2004 period may have triggered important behavioural changes. Adaptation to the major economic downturn of 1994–1998 and to the eventual recovery of 2000–2004 may indeed have brought spouses to a new economic equilibrium. We first document these changes by looking at the evolution of the participation rates and the spouses’ relative wages using data from the Russian Longitudinal Monitoring Survey. Surely, the most impressive change relates to the dramatic decline in the wage rates, and primarily that of male workers in the year 1998. In the years that followed, male workers have managed to regain some of the loss more rapidly than their spouses. Thus not only did the gender wage gap increase during the 2000–2004 period, but so did the intra-household wage gap.

It is thus important to assess how such changes may have impacted the intra-household distribution of welfare within Russian households. Fortunately, if one is willing to assume that the households behave in a Pareto-efficient manner, then it is possible to focus on labour market outcomes to indirectly infer the impact of the changing economic environment on individual welfare. We propose a model that is inspired from the works of Bloemem (2008) and Donni (2003). The model assumes Pareto-efficient outcomes and admits both interior and corner solutions on working hours. Wage rates and the labour supply functions are estimated simultaneously. The main novelty of the empirical model is to allow the parameters of the sharing-rule to change in a discrete manner between the *pre* and *post* 1998 periods.

The main empirical result of the paper suggests that spouses behave in an altruistic manner. An increase in the husband or wife’s wage rate benefits both spouses. On the other hand, we find that in the 2000–2004 period, as the economy got better, husbands have become more egotistic and wives more altruistic: An increase in their relative wage translates into a smaller/larger transfer to their spouse.

This paper attempts to investigate the impact of the enormous shocks the Russian economy has gone through on individual welfare. Given the nature of our results, further research is certainly warranted. We acknowledge that the empirical and theoretical analyses rest on relatively strong assumptions. Chief among these is the implicit assumption that households are only composed of two decision makers. The recent literature suggest that adult children and

elderly parents may also have a say on the decision process. Because Russian households typically include elderly parents, this issue should be accounted for in future research. Furthermore, the empirical model could be refined to allow greater intertemporal interdependence of intra-household decisions. Dynamic collective models are still in their inception but are surely pertinent for the type of problem we investigate in this paper. The important changes that have occurred on the Russian labour market over the last 15 years and the availability of quality data offer an excellent basis to develop and validate the collective models in numerous directions.

Table 6  
 Reduced-Form Parameter Estimates of the Labor Supply Functions  
 $h_j/100$

	Husbands		Wives	
	$D = 0$	$D = 1$	$D = 0$	$D = 1$
<i>Wages and Income Variables</i>				
$\ln \Phi$	0.021 (0.025)	-0.059 (0.033)	-0.027 (0.024)	-0.022 (0.031)
$\ln w_m$	-0.041 (0.016)	0.060 (0.021)	0.006 (0.015)	0.025 (0.019)
$\ln w_f$	-0.009 (0.014)	0.019 (0.018)	0.007 (0.015)	0.009 (0.018)
$(\ln w_m)^2$	-0.004 (0.003)	0.010 (0.004)	0.002 (0.003)	0.005 (0.004)
$(\ln w_f)^2$	0.000 (0.003)	0.001 (0.003)	0.002 (0.003)	-0.001 (0.003)
<i>Observable Characteristics</i>				
Age	0.033 (0.028)	-0.010 (0.036)	0.075 (0.037)	-0.050 (0.045)
Schooling	0.020 (0.008)	-0.021 (0.011)	0.021 (0.009)	-0.020 (0.012)
# Children (0–6)	-0.030 (0.011)	0.034 (0.014)	-0.019 (0.015)	-0.011 (0.017)
# Children (7–18)	-0.004 (0.005)	-0.003 (0.007)	-0.002 (0.005)	-0.007 (0.006)
Post 1998 ( $D = 1$ )	0.113 (0.049)		0.094 (0.049)	

Standard errors in parentheses.

Table 7  
Parameter Estimates of the Wage Equations

	Husbands	Wives
<i>Observable characteristics</i>		
Age/10	-1.204 (1.613)	-4.516 (0.672)
Age <sup>2</sup> /100	1.527 (2.117)	5.249 (0.827)
Schooling/10	0.372 (0.061)	0.319 (0.057)
<i>Region of residence</i>		
Moscow-St-Petersberg	0.353 (0.078)	0.641 (0.076)
North/Northwestern	0.197 (0.084)	0.317 (0.081)
Central/Black Sea	-0.114 (0.074)	-0.073 (0.068)
Volga/Viask/Bolga Basin	-0.365 (0.074)	-0.234 (0.072)
North Caucas	-0.384 (0.082)	-0.324 (0.078)
Ural	-0.117 (0.081)	-0.097 (0.073)
Western Siberia	0.087 (0.086)	0.248 (0.076)
Eastern Siberia (Omitted)	–	–
Post 1998 ( $D = 1$ )	0.112 (0.040)	0.045 (0.038)

Standard errors in parentheses.

Table 8  
Unobserved Heterogeneity Parameters

Parameter	Husbands	Wives
	Labour Supply Equations	
$\lambda^1$	0.728 (0.040)	0.163 (0.040)
$\lambda^2$	0.327 (0.039)	0.368 (0.038)
	Wage Equations	
$\omega^1$	-1.169 (0.314)	-0.345 (0.171)
$\omega^2$	-1.038 (0.311)	-0.500 (0.152)

Standard errors in parentheses.

Table 9  
Discrete Probability Distribution

	Wives		Husbands marginal probabilities
	1	2	
	Husbands	1 0.014 (0.004)	2 0.042 (0.005)
	2 0.068 (0.010)	0.877 (0.010)	0.955
Wives marginal probability	0.082	0.919	1.000

Standard errors in parentheses.

Table 10  
Cholesky Matrix of:  $\Sigma_{uv}$

	$u_{imt}$	$u_{ift}$	$\nu_{imt}$	$\nu_{ift}$
$u_{imt}$	0.125 (0.001)			
$u_{ift}$	0.087 (0.002)	0.078 (0.001)		
$\nu_{imt}$	0.067 (0.034)	*	0.939 (0.013)	
$\nu_{ift}$	–	-0.094 (0.045)	0.344 (0.018)	0.840 (0.011)

COVARIANCE MATRIX: $\Sigma_{uv}$				
	$u_{imt}$	$u_{ift}$	$\nu_{imt}$	$\nu_{ift}$
$u_{imt}$	0.016	0.011	0.008	0
$u_{ift}$	0.011	0.014	0	-0.007
$\nu_{imt}$	0.008	0	0.892	0.330
$\nu_{ift}$	0	-0.007	0.330	0.833

Standard errors in parentheses.

\*  $\text{Chol}_{32} = -\text{Chol}_{21} * \text{Chol}_{31} / \text{Chol}_{22}$

– Constrained to zero

Table 11  
Parameters of the Structural Model

<i>Variables</i>	Parameters	Husbands		Wives	
		$D = 0$	$D = 1$	$D = 0$	$D = 1$
$\ln(\text{Own-Wage})$	$\alpha_m, \alpha_f$	-3.863 (2.137)	-3.483 (2.348)	1.718 (2.332)	4.353 (3.114)
$\ln(\text{Own-Wage})^2$	$\beta_m, \beta_f$	-0.498 (0.360)	0.729 (0.641)	0.238 (0.293)	0.433 (0.497)
$\ln(\text{Own-Share})$	$\gamma_m, \gamma_f$	2.068 (2.536)	-3.862 (2.122)	-2.718 (2.420)	-4.889 (1.944)
<i>Sharing-Rule(d)</i>		$D = 0$		$D = 1$	
$\ln(w_m)$	$\theta_{wm}$	0.220 (0.392)		0.628 (0.107)	
$\ln(w_f)$	$\theta_{wf}$	-0.417 (0.316)		-0.263 (0.192)	
$\ln(w_m)^2$	$\theta_{w2m}$	0.073 (0.129)		0.143 (0.063)	
$\ln(w_f)^2$	$\theta_{w2f}$	-0.014 (0.120)		-0.024 (0.046)	
<i>Labour Supply</i>					
<i>Continuity Parameters</i>					
$s$			0.018 (0.014)		
$S$			0.019 (0.011)		
<i>Sharing-Rule</i>					
<i>Continuity Parameters</i>					
$r$		0.009 (0.013)		-0.005 (0.003)	
$R$		0.007 (0.006)		0.004 (0.002)	

Standard errors in parentheses.

Table 12  
Elasticities of the Sharing-Rule (On the Participation Frontier)

	Husbands		Wives	
	$D = 0$	$D = 1$	$D = 0$	$D = 1$
$\partial \ln \Phi_j / \partial \ln w_m$	0.521 (0.492)	0.927 (0.102)	0.331 (0.491)	0.097 (0.101)
$\partial \ln \Phi_j / \partial \ln w_f$	0.002 (0.289)	0.220 (0.159)	0.783 (0.288)	0.659 (0.160)
$\partial \Phi_j / \partial w_m$	102.730 (96.981)	152.125 (16.558)	65.270 (96.981)	15.875 (16.558)
$\partial \Phi_j / \partial w_f$	0.511 (61.723)	42.023 (30.498)	167.489 (61.723)	125.977 (30.498)

Standard errors in parentheses.

Table 13  
Labour Supply Elasticities

	Husbands		Wives	
	Constant Sharing-Rule ( $\Phi$ )			
	$D = 0$	$D = 1$	$D = 0$	$D = 1$
$\partial \ln h_m / \partial \ln w_m$	-0.079 (0.044)	-0.114 (0.049)		
$\partial \ln h_f / \partial \ln w_f$			0.030 (0.051)	0.085 (0.066)
	Variable Sharing-Rule ( $\Phi$ )			
$\partial \ln h_j / \partial \ln w_m$	-0.051 (0.049)	-0.204 (0.076)	-0.021 (0.017)	-0.011 (0.010)
$\partial \ln h_j / \partial \ln w_f$	0.000 (0.016)	-0.090 (0.053)	-0.020 (0.018)	0.008 (0.056)

Standard errors in parentheses.

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