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Keywords: Simultaneous Tobit, Labor Supply

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1 Introduction

OECD (2008) devotes a chapter for the discussion surrounding Japanese labor market, where the population of the working-age group has rapidly decreasing¹. OECD (2008) points out it is necessary to increase labor input from females to cope with population aging trend because Japanese females have stronger tendency to leave the labor market than in any other developed country when they marry (OECD (2002)). Although many females return to labor market after withdrawal at the marriage, many of them don't choose to work full time. The proportion of females who work part-time is one of the highest in OECD countries at 41% (OECD (2008)).

The aim of this paper is to examine what discourage Japanese married female from working. To achieve this aim, this paper follows Lundberg (1988) who analyzes labor supply behaviour of U.S. married couples taking account for possibility that their decisions are jointly determined. Labor supply functions for husbands and wives are estimated using simultaneous Tobit (model 4 in terms of Maddala (1983), explained in detail by Matsuura and McKenzie (2009)).

Compared to existing empirical studies of Japanese married female labor supply, for example, Hill (1989), Higuchi (2001), Takeuchi (2004), and Ma (2007), this paper has following features. The estimation method used in this paper takes account of the possibility that both wife's labor supply and husband's labor supply are simultaneously determined, unlike previous studies which assumes husband's labor supply is predetermined.

The empirical results can be summarized as follows. Husband's market work reduces wife's market work while wife's market work does not affect husband's market work at least according to the results for pooled whole sample. Wage effects differ: both wages of husbands and wives affect wives' labor supply negatively while husbands' wages affect husband's labor supply positively.

The remainder of this paper is as follows. Section 2 explains the empirical model, the data and the characteristics of hours of work and housework of each married couple in our sample. Section 3 presents the empirical results, and Section 4 contains a conclusion.

2 Model

There are a lot of studies which analyze a family joint labor supply behaviour, both theoretically and empirically. Chiappori (1988) introduces a sophisticate approach which eases an assumption that there is one only decision maker. Chiappori (1988) assumes there are not one but two decision makers (typically, a husband and a wife)

¹According to Japanese National Institute of Population and Social Security Research, the share of the population of the working-age group has been declining and will be below 60% in 2020.

cooperate each other so as to maximize each other utility. However, empirical researches in this setting like van Soest (1995), or Blundell et al. (2007) must make some restriction to estimate. This paper uses much more simpler approach.

This paper uses follows Lundberg (1988) who analyzes labor supply behaviour of U.S. married men and women treating each spouse's labor supply as endogenous.

This paper assumes a family consists of a husband and a wife maximize following utility function. Each member of couple maximize

$$U_i(T - h_i, C), \quad (1)$$

where h represents hours of market work and C represents consumption of the family. In this sense, a family is assumed to share their consumption. A subscript h, w represents a husband and a wife.

Each family faces following budget constraint,

$$C \leq Y + w_h h_h + w_w h_w + H(T - h_h, T - h_w) \quad (2)$$

where w represents each wage and Y represents a couple's non-labor income. A function H represents a household production function. Hereafter, this paper denotes the budget constraint above as $B(h_h, h_w, \cdot)$. Because the model is static in this paper, so

$$C = B(h_h, h_w, \cdot) \quad (3)$$

Each member of a couple chooses hours of work to maximize above utility, so their reaction functions of hours of work h_h^*, h_w^* are

$$\begin{cases} h_h^* = \arg \max_{h_h} U_h(T - h_h, B(h_h, h_w^*, \cdot)) \\ h_w^* = \arg \max_{h_w} U_w(T - h_w, B(h_h^*, h_w, \cdot)) \end{cases} \quad (4)$$

where $\bar{H} \geq h_i^* \geq 0$ ($i = h, w$).

This paper assumes following closed linear labor supply reaction function,

$$H_h^* = \alpha_h + \gamma_h H_w^* + \delta_h Z_h + \beta_h^h w_h + \beta_h^w w_w + \epsilon_h, \quad (5)$$

$$H_w^* = \alpha_w + \gamma_w H_h^* + \delta_w Z_w + \beta_w^h w_h + \beta_w^w w_w + \epsilon_w, \quad (6)$$

$$H_i = \begin{cases} H_i^* & \text{if } H_i^* > 0 \\ 0 & \text{if } H_i^* \leq 0 \end{cases} \quad i = h, w, \quad (7)$$

where H represents hours worked, w represents market wages, and Z represents other variables which affects their preferences for leisure, or a productivity in household production such as number of children or non-labor income.

Because this paper assumes a couple share their consumption completely, it is necessary to use variables which affect not productivity (and consumption) but taste for identification. This paper uses information of parents of each member of a couple. First, this paper uses each parent's age to take account for the possibility that a taste of each member of couple is affected by his/her parent's taste varied by cohort. Second, this paper uses information of parent's job at each member of a couple is 15 years old to take account for the possibility that the memory of childhood affect his/her taste.

This paper estimates those equation by two-step simultaneous tobit. Generated regressor problem is removed by variance correction proposed by Murphy and Topel (1985) which explained by Matsuura and McKenzie (2009) in detail. To estimate, this paper regresses hours of work on whole exogenous explanatory variables as explanatory variables by Tobit in the first step. In the second step, (5) and (6) will be estimated using predicted hours of work obtained by the result of the first step as an explanatory variable.

Explanatory variables, Z_i , includes the variables proxy taste for leisure/consumption or productivity in household production. This paper uses following variables. First, to take account for child care which is large part in housework, the number of children are used as explanatory variables. Hours of child care can be thought to be decreasing as a child gets older, the number of children aged 0-2, the number of children aged 3-5, and the number of children aged 6-18, are defined separately. Second, to take account of the possibility that co-residence with parent who help housework decrease an individual's hours of housework, dummy variables which denote whether the individual live with his/her parent or not are defined as explanatory variables.

To take account of the possibility that hours of housework depend on size of dwellings and households, both number of rooms and number of households are defined as explanatory variables. To proxy non-labor income, variables which proxy each couple's wealth level, saving, securities, liabilities and income not earned by a couple are also used as explanatory variables.

To estimate above labor supply reaction function, it is necessary to obtain market wage regardless an individual works or not. To obtain market wage, this paper uses an auxiliary regression for wages in standard settings and uses imputed wage for all individuals. This paper uses an individual's education level, and work experience as proxy variable of human capital accumulation which affects market wage level following Mincer (1985). In order

to measure an individual's education level, this paper uses the following schooling dummy variables, junior high school dummy, 2-year college dummy, and university dummy, as proxy variables for education. As a result, senior high school is the base level of education. To take account of possibility that wages rise with job seniority, as Topel (1991) pointed out, this paper distinguishes work experience as a whole, denoted by *Exp*, and work experience in the current work place, denoted by *Tenure*².

This paper utilizes data from the Keio Household Panel Survey (KHPS) conducted by Keio University from 2005 to 2009. Kimura (2005) contains details of the sampling methods used to obtain KHPS and the sample characteristics of KHPS. The first wave of KHPS, KHPS2004, sampled about 4000 households with respondents who were aged between 20 and 69, and includes married and unmarried males and females. This KHPS contains not only respondent information but also spouse's respondent information. This feature enables us to estimate labor supply functions using spouse's information. Descriptive statistics is summarized in Table 1.

3 Estimation Results

Estimation results are summarized in table 2. In this table, the estimation results for whole couples are shown in columns [1] to [2], for couples with children aged 0-18 in columns [3] to [4], and for couples without children aged 0-18 in columns [5] to [6].

It should be noted parents' information, which is necessary for an identification, affects labor supply and the fathers' effects and mothers' effects differ. For wives, the younger their father, the less they work while the younger their mother, the more they work. Husbands' labor supply seem not to be affected by their parent's ages.

The factors that affect the labor supply differ between husbands and wives. For example, the saving and income not earned by the couple significantly decreases labor supply for wives regardless the couple has a child, but not for husbands. The effects of having children on labor supply differ between husband and wives, and differ with age of children. The number of children aged 0-2 and 3-5 significantly reduce wives' labor supply. The variables proxy Non-labor income like liabilities, securities, saving, or income not earned by couple significantly affect both couple's labor supply, but the magnitude differs between husbands and wives. In general, the effect is larger for females than males, except for liabilities which positively affect husband's labor supply while not for wife's.

The effects of wages also differ. Increase in husbands' wage reduce wives' labor supply while increase husbands' labor supply. Increase in wives' wage reduce both husbands' and wives' labor supply.

According to estimation results, although husband's market work reduces wife's market work, wife's market work does not affect husband's market work. In contrast, wife's housework increase husband's market work, husband's

²The auxiliary regression results are omitted.

housework does not affect wife's market work.

4 Conclusion

The empirical results can be summarized as follows. Although husband's market work reduces wife's market work, wife's market work does not affect husband's market work. The effects of wages differ. Increase in husbands' wage reduce wives' labor supply while increase husbands' labor supply. Increase in wives' wage reduce both husbands' and wives' labor supply.

There are two channels which a wife's decrease in hours of market work affects the utility of husband. First channel is a decrease in a labor market income of a wife caused by a wife's decrease in hours of market work. Second channel is an increase in a household production caused by a wife's decrease in hours of market work. The estimation results here implies these two channel is mixed and cannot be observed effects. When a wife's wage increases, both two channels seems to increase the utility of a husband.

These results imply that husbands tend to specialize themselves in market work while wives tend to specialize themselves in housework in Japan. The possible reasons of this tendency are as follows. First, Japanese gender gap in pay is the largest among developed developed countries (See Mincer (1985), Jacobsen (1998) Blau and Kahn (2003), and Miyoshi (2008)). Second, the productivity of housework for husbands may be lower than that of wives. In Japan, husbands were not taught "home economics" which was a subject about how to do housework before 1991 in junior high school.

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Table 1: Descriptive Statistics

	Mean	Std.err
Number of Children 6-18	0.95	1.00
Number of Children 3-5	0.19	0.44
Number of Children 0-2	0.13	0.37
Number of Household	3.97	1.27
Saving (10 thousand yen)	596.55	899.36
Securities (10 thousand yen)	142.67	601.50
Liabilities (10 thousand yen)	834.30	1273.47
Number of Room	5.42	2.00
Income not earned by the couples (10 thousand yen)	55.10	274.29
Live With Husband's parent	3.9%	
Live with other parent	11.1%	
Age of Husbands	45.23	8.75
University (Husbands)	38.5%	
Other School (Husbands)	9.9%	
Junior High (Husbands)	4.8%	
Work Exp (Husbands in 1/10 years)	2.36	0.95
Tenure (Husbands in 1/10 years)	0.99	1.17
Hours worked in a week (husbands)	49.36	12.55
Wage Rate (hourly, yen husbands)	2717.56	1617.11
Age of Wives	43.01	8.26
University (Wives)	15.8%	
Other School (Wives)	31.6%	
Junior High (Wives)	3.0%	
Work Exp (Wives in 1/10 years)	1.35	0.84
Tenure (Wives in 1/10 years)	0.21	0.52
Hours worked in a week (wives)	17.77	17.55
Wage Rate (hourly, yen Wives)	1891.55	2556.82
Per capita Nursery Schools ($\times 1000$)	0.13	0.06

Notes:

(1) Source: KHPS2004-2009 except for Per capita Nursery Schools in a prefecture. Per capita Nursery school is computed by an information of survey of mhlw called “社会福祉施設等調査” and population census. (2005-2007).

Table 2: Estimation Results: Labor Supply Response Function: Tobit

	Whole		With Children		Without Children	
	Wives	Husbands	Wives	Husbands	Wives	Husbands
Spouse's hours of working	-0.563** [0.246]	0.009 [0.047]	-0.326 [0.295]	0.072 [0.054]	-0.234 [0.259]	-0.064 [0.088]
Imputed Husband's wage	-0.003*** [0.001]	0.001*** [0.001]	-0.004*** [0.001]	0.001 [0.001]	-0.003* [0.002]	0.003*** [0.001]
Imputed Wife's wage	-0.006*** [0.001]	-0.002*** [0.001]	-0.009*** [0.002]	-0.002* [0.001]	0.003 [0.002]	-0.001 [0.001]
Own Father's birth year	-0.380** [0.153]	0.032 [0.069]	-0.523*** [0.182]	0.055 [0.091]	-0.578** [0.261]	0.088 [0.129]
Own Mother's birth year	0.504*** [0.178]	0.028 [0.081]	0.331 [0.211]	-0.004 [0.102]	0.957*** [0.321]	-0.016 [0.153]
Own age	-0.101 [0.182]	-0.257*** [0.078]	0.188 [0.215]	-0.170* [0.099]	-0.364 [0.303]	-0.454*** [0.146]
Own Father's Job	6.498	-0.135	11.428**	2.773*	-	-
Self Employee	4.125	[1.439]	[4.864]	[1.637]	-	-
Own Father's Job	4.856	5.471	-0.331	5.839	3.07	-7.936***
Self Employed Profession	[7.261]	[5.655]	[21.286]	[5.334]	[6.213]	[3.049]
Own Father's Job	17.920***	-0.706	21.603***	1.331	1.487	-6.860*
Family Worker	[5.449]	[2.018]	[6.223]	[2.446]	[9.418]	[3.682]
Own Father's Job	6.222	-0.319	12.567***	1.239	0.354	-5.044*
Employed	[4.081]	[1.382]	[4.783]	[1.557]	[6.220]	[2.785]
Own Father's Job	-32.063***	-9.108***	-24.891**	-10.003***	-14.748	-12.816***
Work at Home Job	[11.141]	[2.677]	[11.583]	[3.059]	[8.971]	[3.834]
Own Father's Job	-4.324	-4.499*	9.195	4.193	3.55	-3.496
Contract for Work (Ukeoi)	[5.351]	[2.594]	[6.182]	[3.798]	[6.968]	[3.589]
Own Father's Job	4.775	-0.911	10.734**	0.313	-	-
Not in Employed	[4.472]	[1.656]	[5.301]	[1.882]	-	-
Own Mother's Job	7.404	-8.386***	11.679	5.909	-	-
Self Employee	[6.587]	[3.056]	[12.604]	[6.124]	-	-
Own Mother's Job	-1.084	-13.180**	-5.577	0.489	3.312	-15.755***
Self Employed Profession	[10.848]	[6.286]	[24.678]	[8.038]	[8.066]	[4.311]
Own Mother's Job	10.37	-9.364***	10.296	3.499	9.974	-14.380***
Family Worker	[6.450]	[3.069]	[12.532]	[6.143]	[7.772]	[4.279]
Own Mother's Job	13.181**	-10.419***	12.916	2.86	11.814	-15.011***
Employed	[6.450]	[3.047]	[12.343]	[6.070]	[7.751]	[4.387]
Own Mother's Job	2.336	-10.737***	2.226	3.694	6.675	-19.572***
Work at Home Job	[6.863]	[3.163]	[12.546]	[6.180]	[8.900]	[4.603]
Own Mother's Job	21.052***	-16.847***	16.678	1.732	10.522	-16.921***
Contract for Work (Ukeoi)	[7.723]	[3.762]	[13.056]	[6.613]	[7.993]	[4.198]
Own Mother's Job	12.157*	-10.390***	11.803	2.946	-	-
Not in Employed	[6.457]	[3.008]	[12.349]	[6.031]	-	-
Live with Husband's parent	6.240**	-1.265	5.853*	-1.534	1.622	-1.403
	[2.954]	[1.422]	[3.325]	[1.668]	[5.440]	[2.865]
Live with Wife's parent	3.065	-0.798	4.764**	-0.223	-2.562	-2.682
	[1.983]	[0.940]	[2.419]	[1.172]	[3.180]	[1.662]
Number of room	0.209	-0.545***	0.890*	-1.060***	0.08	0.254
	[0.365]	[0.164]	[0.498]	[0.212]	[0.567]	[0.295]
Number of household	1.181	0.269	0.841	0.174	1.488	0.645
	[0.732]	[0.332]	[1.000]	[0.489]	[1.005]	[0.531]
Num of Children 6-18	-1.535*	1.169***	-0.18	-0.025	-	-
	[0.908]	[0.409]	[0.157]	[0.064]	-	-
Num of Children 3-5	-12.728***	0.441	-0.288***	0.089**	-	-
	[1.785]	[0.957]	[0.101]	[0.045]	-	-
Num of Children 0-2	-16.907***	-1.128	-2.451*	1.304**	-	-
	[2.227]	[1.125]	[1.305]	[0.614]	-	-
Securities	-0.235*	-0.095**	-9.522***	1.659	-0.298	-0.198**
	[0.135]	[0.046]	[2.037]	[1.022]	[0.193]	[0.089]
Savings	-0.159**	0.019	-12.712***	0.1	0.09	-0.006
	[0.079]	[0.034]	[2.339]	[1.160]	[0.117]	[0.057]
Liabilities	-0.013	0.034*	-0.073	0.072***	0.066	-0.019
	[0.045]	[0.020]	[0.061]	[0.025]	[0.070]	[0.040]
Income earned by other couple	-0.897***	-0.212**	-1.102***	-0.27	-0.648*	-0.203
	[0.272]	[0.106]	[0.280]	[0.291]	[0.343]	[0.146]
Rivers-Vuong Test	-2.26**	-0.86	0.84	2.47**	-1.06	-0.24
Observations		2312		1615		697

Notes:

- (1) Standard errors are in brackets.
- (2) *, **, *** indicate significance at the 10%, 5%, and 1% levels, respectively.
- (3) Coefficients of the regional dummies and constants are not reported.
- (4) Middle two column reports the estimation result for the sample with pre-school children and right two column reports the result for the sample without pre-school children.

Table 3: Estimation Results: Labor Supply Response Function: Tobit

	Whole		With Children		Without Children	
	Wives	Husbands	Wives	Husbands	Wives	Husbands
Spouse's hours of working	-0.627 [0.397]	0.041 [0.092]	-0.079 [0.461]	0.009 [0.107]	-0.379 [0.484]	0.004 [0.088]
Imputed husband's wage	-0.002 [0.001]	0.001 [0.001]	-0.003+ [0.002]	0.000 [0.001]	-0.002 [0.002]	0.003*** [0.001]
Imputed wife's wage	-0.007*** [0.002]	-0.001 [0.001]	-0.010*** [0.002]	-0.002 [0.001]	0.002 [0.003]	0.000 [0.001]
Own Father's birth year	-0.472** [0.188]	0.112 [0.087]	-0.389 [0.245]	0.110 [0.108]	-0.697** [0.302]	0.112 [0.142]
Own Mother's birth year	0.587*** [0.224]	-0.065 [0.099]	0.164 [0.291]	-0.112 [0.124]	1.144*** [0.376]	0.005 [0.165]
Own Age	-0.253 [0.232]	-0.307*** [0.091]	0.221 [0.259]	-0.212+ [0.114]	-0.474 [0.413]	-0.395** [0.158]
Own Father's Job Self-employed	2.181 [2.574]	0.493 [1.217]	1.724 [3.102]	1.740 [1.260]	0.795 [4.178]	-3.459 [2.474]
Own Father's Job Work at home	-3.111 [3.925]	-3.481** [1.592]	-1.481 [4.386]	-2.357 [1.963]	-11.947+ [6.927]	-6.227** [2.879]
Own Father's Job Employed	0.647 [2.356]	-0.579 [1.043]	-0.154 [2.825]	0.034 [1.173]	-1.750 [3.796]	-3.483+ [2.070]
Own Mother's Job Self-employed	-4.361+ [2.558]	1.734 [1.072]	-2.113 [3.060]	1.964 [1.274]	-5.775 [4.125]	1.080 [1.849]
Own Mother's Job Work at Home	-3.151 [2.007]	-0.197 [0.869]	-4.547** [2.313]	-0.049 [1.032]	-0.796 [3.364]	0.062 [1.692]
Own Mother's Job Employed	1.603 [1.690]	0.413 [0.810]	1.979 [1.865]	-0.241 [0.904]	3.182 [3.206]	2.398 [1.699]
Live with Husband's parent	0.072 [3.520]	-2.479 [1.576]	-1.965 [4.112]	-2.609 [1.875]	-0.970 [6.185]	-2.283 [2.781]
Live with Elderly person (other than husband's parent)	0.204 [2.398]	-0.674 [1.071]	-0.425 [2.853]	-0.853 [1.298]	-5.801 [3.954]	-0.370 [1.889]
Num of rooms	0.389 [0.446]	-0.330+ [0.198]	1.112+ [0.628]	-0.753*** [0.266]	0.560 [0.781]	0.521 [0.341]
Num of household	2.129** [0.908]	0.330 [0.413]	2.263+ [1.296]	0.665 [0.589]	2.083+ [1.240]	0.381 [0.591]
Num of Children 6-18	-2.190** [1.111]	0.876+ [0.502]	-3.344*** [0.191]	0.187*** [0.072]	-	-
Num of Children 3-5	-15.216*** [2.158]	0.978 [1.622]	-11.674*** [0.135]	0.396*** [0.062]	-	-
Num of Children0-2	-19.683*** [2.649]	-1.414 [1.909]	-14.085*** [1.516]	-2.098*** [0.751]	-	-
Securities	-0.323+ [0.168]	-0.094 [0.067]	-0.003 [2.388]	-0.066 [1.624]	-0.800*** [0.278]	-0.181 [0.130]
Saving	-0.165 [0.102]	0.027 [0.042]	-0.313 [2.813]	0.094 [1.910]	0.035 [0.140]	-0.024 [0.063]
Liabilities	0.061 [0.053]	0.027 [0.023]	0.010 [0.073]	0.073*** [0.027]	0.119 [0.078]	-0.043 [0.041]
Income not earned by couple	-1.102*** [0.406]	-0.066 [0.144]	-2.350*** [0.741]	-0.081 [0.317]	-0.622 [0.378]	-0.100 [0.146]
Per capita Nursery School (in a prefecture)	75.260*** [12.891]	-9.729 [9.209]	103.865*** [15.231]	-9.669 [12.315]	44.052** [21.473]	0.506 [10.790]
Observations	1699		1179		520	

Notes:

- (1) Standard errors are in brackets.
- (2) +, **, *** indicate significance at the 10%, 5%, and 1% levels, respectively.
- (3) Coefficients of the regional dummies and constants are not reported.
- (4) Middle two column reports the estimation result for the sample with pre-school children and right two column reports the result for the sample without pre-school children. (5) Sample periods are 2005-2007