Exploring the long-term influence of childcare on the Japanese women's participation in labor market from the perspective of time use*

by Lili XU[1], Junyi ZHANG[2] and Akimasa FUJIWARA[3]

1. Introduction

Women have to balance the changes in work roles and family relationship in their lives, which will produce a comprehensive reaction from individuals, corporations, and government in our society. Such balance was brought by work and domestic factors acted together since industrialization that promoted the beginning of women's participation in labor market and consequently the shift from "home-based to factory-based production and employment" (Collins, 2004). The demand for women to take care of child is the key factor in dealing with such balance. According to Hamilton (1995), young children significantly reduce the annual work experience of married mothers through a statistical review of women in American society in 1990s. Senda (2002) found that women in clerical or sales/service occupation show lower continuity rate than those who were professional or manual occupation between their first pregnancy and one year after the first childbirth. After childbirth, the availability of childcare is another influence factor in women's participation in labor market. Hallman *et al.* (2003) hypothesized that women in Guatemala with lower unemployment rates and fewer working hours are "in part due to the lack of availability of childcare". In Japan, employment rate of unmarried women has not changed so much (about 80%) between 1996 and 2006, the employment rate of married women with children under 10 years old increased from 26% in 1996 to 33% in 2006 and it is still much lower than that of unmarried women. On the other hand, the share of married women with children under 10 years old was about 40%, which has not changed so much between 1996 and 2006. Due to the rapid progress of aging society and low birth rate, it is necessary to promote women's participation in labor market.

This paper applies the Survey on Time Use and Leisure Activities collected by the Ministry of General Affairs to investigate the long-term influence of childcare on the Japanese women's participation in labor market based on time allocation model incorporating activity participation. The time use model explicitly incorporates various interactions and interdependences in time use behavior, including activity participation, inter-activity interactions, as well as relative importance of different activities.

2. Model

For the time allocation model, a multi-linear function (Zhang *et al.*, 2005) is adopted to represent individual time allocation behavior by assuming that individuals allocate their time on activities so that the utility is maximized subject to their available time.

$$\textit{Maximize} \quad u_i = \Sigma_j \gamma_{ij} u_{ij} + \Sigma_j \Sigma_{j' \neq j} \delta \gamma_{ij} \gamma_{ij'} u_{ij} u_{ij'} \tag{1}$$

$$\textit{Subject to} \quad \sum_j t_{ij} = T_i, t_{ij} \geq 0 \tag{2}$$

$$u_{ij} = \rho_{ij} \ln(t_{ij}), \rho_{ij} = \exp(\Sigma_k \beta_k x_{ijk} + \xi_{ij}), \Sigma_j \gamma_{ij} = 1, \gamma_{ij} \geq 0 \tag{3}$$

where, *i* and *j* refer to individual and activity; t_{ij} is the allocated time to activity *j*, T_i is available time of individual *i*; u_{ij} is utility of activity and γ_{ij} is weight parameter of u_{ij}, reflecting the relative interest/importance of activity *j*; ρ_{ij} represents individual *i*'s heterogeneous preference over activity *j*, reflecting the influences of age, education, income and so on; δ is inter-activity interaction parameter.

Lagrange function is used to maximize the utility, and the time allocated to activity *j* can be derived as:

$$t_{ij} = \frac{\gamma_{ij} \rho_{ij} (1 + \Sigma_{j' \neq j} \delta \gamma_{ij'} \rho_{ij'} \ln(t_{ij} + 1))}{\Sigma_{j'} (\gamma_{ij'} \rho_{ij'} (1 + \Sigma_{j'' \neq j'} \delta \gamma_{ij''} \rho_{ij''} \ln(t_{ij'} + 1)))} T_I + \eta_{ij} = \kappa_{ij} T_i + \eta_{ij}, \eta_{ij} \sim N(0, \sigma_{ij}^2) \tag{4}$$

---

* Keywords: Time use, women, social childcare, employment status

[1] B. Eng, xulilimaya@hotmail.com; [2] Dr. Eng, zjy@hiroshima-u.ac.jp; [3] Dr. Eng, afujiw@hiroshima-u.ac.jp
Graduate School for International Development and Cooperation, Hiroshima University, 1-5-1 Kagamiyama, Higashi-Hiroshima, 739-8529, Japan, TEL&FAX 082-424-6919

To incorporate the activity participation into the processes of individual time allocation, a binary logit model is adopted to represent the activity participation selection. V_{ij1} represents utility of systemic part for participation, and for non-participation part we define it as 0, w_{ij1} represents the participation of activity j, and w_{ij2} represents non-participation, then we can get the probability of participation in activity j as shown in equation (6) if the error term ε_{ij1} follows a Gumbel distribution.

$$U_{ij1} = V_{ij1} + \varepsilon_{ij1} \tag{5}$$

$$Pr(w_{ij1}) = F(\varepsilon_{ij1}) = exp(V_{ij1}) / (1 + exp(V_{ij1})) \tag{6}$$

To get the joint probabilities of activity participation and corresponding time allocation, two error terms are transformed into bivariate standard normal distribution variables with correlation μ_{ij1} (Lee, 1983). Due to the space limitation, these derivation processes are not shown here. Details refer to Xu *et al*. (2009). The log-likelihood function of the time allocation model incorporating activity participation is:

$$LogL_i = \Sigma_j \begin{Bmatrix} D_{ij}[-ln(\sigma_{ij}) + ln(\Phi(\frac{t_{ij} - \kappa_{ij} T_i}{\sigma_{ij}}))] + D_{ij}\, ln(\phi(\frac{J_1(\varepsilon_{ij1}) - \mu_{ij1}((t_{ij} - \kappa_{ij} T)/\sigma_{ij})}{\sqrt{1 - \mu_{ij1}^2}})) \\ + (1 - D_{ij})\, ln(1 - Pr(w_{ij1})) \end{Bmatrix} \tag{7}$$

$$J_1(\varepsilon_{ij1}) = \Phi^{-1}(F(\varepsilon_{ij1})) = \Phi^{-1}(Pr(w_{ij1})) \tag{8}$$

where D_{ij} is a dummy variable to indicate participation in activity j ("1" means participation and "0" for non-participation); ϕ represents the standard normal probability density distribution function; Φ represents the standard normal cumulative density distribution function; Φ^{-1} indicates the inverse of standard normal cumulative density distribution function. The maximum likelihood estimation method is applied in this study.

3. Data

The survey data in 2006 include the individual attributes, household attributes, time allocation on different activities and situation of children under 10. We focus on the influence of no child, whether the child is under social childcare or extended social childcare if she have children. Moreover, we select sample data from age 20 to 50 for one reason that women's participation in labor market mainly concentrates on this period, another reason is that most childcare demand is also generated in this period.

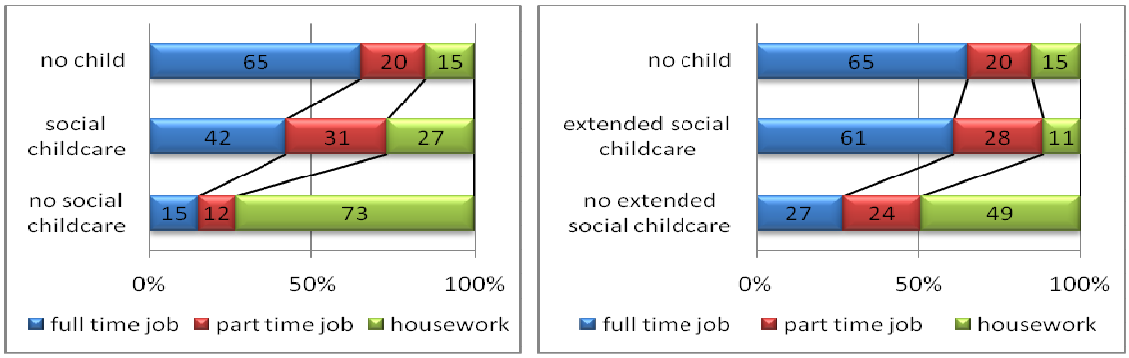

Fig.1 Employment status and childcare

Considering the purpose of this study is to investigate women's participation in labor market, therefore only full time job, part time job, and housework are chosen as the employment status alternatives. As shown in figure 1, full time job rate without children is higher compared with child; and for the women with child, the rate of full time job with extended social childcare is higher than without, which indicate the power of influence no child and social childcare on women's employment status.

Generally speaking, activities are classified into 3 main groups, compulsory activities to support the family and the society, maintain activities to maintain the life physically, and discretionary activities to relax oneself and express personality unrestricted. Here we focus on women's issues, those who are in charge of housework and taking care of children in the family. In order to make more detail research the relationship between such committed activities and

other activities, we subdivide the compulsory activity into two groups: compulsory-contracted including paid work, go to school; and compulsory-committed including housework, family care, taking care of children. Figure 2 shows the aggregate time allocation among 4 types of activities grouped by no child, extended social childcare, no extended social childcare, and no social childcare. The decreasing compulsory-contracted activity time and increasing compulsory-committed time also indicate the influence power of childcare on women's time allocation.

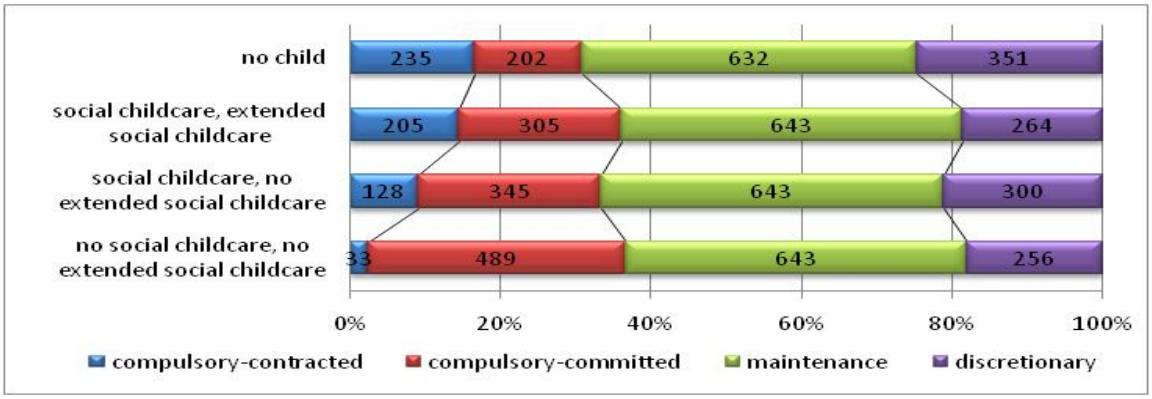

Fig.2 Time allocation and childcare

4. Model Estimation

The adjusted McFadden's rho-squared is 0.2, suggesting a relatively satisfactory model accuracy. As can be seen, the correlation between activity participation and time allocation are significant, which proved the interaction for activity participation part and time allocation part. Inter-activity interaction parameter is negative which is consistent with our previous studies. This implies that competition of time allocation among different activities. The sorting order for relative importance of activity is maintenance activity, compulsory-committed activity, discretionary activity, and compulsory-contracted activity. Compulsory-committed activity ranks as the second place just after maintenance activity while compulsory-contracted activity ranks last, suggesting the high responsibility of taking care of the children and housework for women from age 20-50, and the lowest degree of importance for work related activities.

Table1. Model estimation results (1)

	correlation between activity participation and time allocation		variance of time allocation model part		relative importance of activity	
	estimate	t-statistic	estimate	t-statistic	estimate	t-statistic
maintenance activity			1.363	231.015	0.278	
compulsory-contracted activity	-0.857	-188.826	1.658	109.024	0.238	660.513
compulsory-committed activity	0.661	53.824	1.346	182.934	0.243	256.146
discretionary activity	0.401	15.680	1.454	215.892	0.241	441.541
interaction of activities					-0.211	-422.841
log-likelihood of null model					-800992	
log-likelihood at convergence					-640523	
number of variables to be considered for adjustment					26	
number of observations					29823	
Adjusted McFadden's rho-squared					0.200	

Explanatory variables introduced into the model are shown in table 2. To accommodate the variations across activities among participation part and time allocation part, utility of explanatory variables are first defined as a composite variable, respectively, and then activity-specific parameters are introduced into the model. Most of the parameters are statistically significant, suggesting that model performance is acceptable. We noticed that only two parameters are not statistically significant: dummy variable for extended social childcare and age. The data used in this study are selected from age 20 to 50, and the influence of this age group on time allocation is not statistically significant. Dummy variable for social childcare is statistically significant while extended social childcare is not, which indicate that whether extended or not when the child is in social childcare is not an influential characteristic in women's time allocation decision making.

To investigate the influential proportion of variables in utility function that determine the time allocation, firstly we define proportion of variance for each explanatory variable in equation (9). The results are shown in figure 3, marital status take the highest influential proportion with 1/2, followed by no child with 1/4, and social childcare is

also an important influential variable with 10%. In addition, employment status also constitutes a large proportion. This figure also confirms the influence of no child and social childcare on women's activity participation and corresponding time allocation behavior.

$$\{S_j\}\% = \frac{var(\beta_k x_{ijk})}{var(\sum_k \beta_k x_{ijk})} = \frac{\beta_k^2 \, var(x_{ijk})}{\sum_k var(\beta_k^2 \, var(x_{ijk}))} \tag{9}$$

Table2. Model estimation results (2)

Parameter	Estimate	t-statistic
explanatory variables		
population in household	0.0015	5.0106
no child	-0.0435	-28.2280
dummy variable for social childcare (1,yes; 0, no)	-0.0280	-20.5610
dummy variable for extended social childcare (1,yes; 0, no)	0.0005	0.3096
number of room	-0.0004	-1.6379
income level	-0.0012	-8.7669
age	-0.0001	-0.8182
dummy variable for higher education (1,yes; 0, no)	0.0012	2.6491
marital status	0.0654	23.9981
dummy variable for full time job (1,yes; 0, no)	-0.0254	-19.5358
dummy variable for part time job (1,yes; 0, no)	-0.0222	-16.0572
dummy variable for weekend (1,yes; 0, no)	-0.0081	-10.1113
activity participation part: base alternative (non-participation)		
constant for discretionary activity	3.2466	78.7438
composite variable for discretionary activity	-8.1112	-8.8891
constant for compulsory-committed activity	2.6382	29.1716
composite variable for compulsory-committed activity	28.5891	31.1449
constant for compulsory-contracted activity	-0.3928	-33.2767
time allocation part: base alternative (maintenance activity)		
composite variable for discretionary activity	0.0721	2.2499
composite variable for compulsory-committed activity	1.9431	29.1721

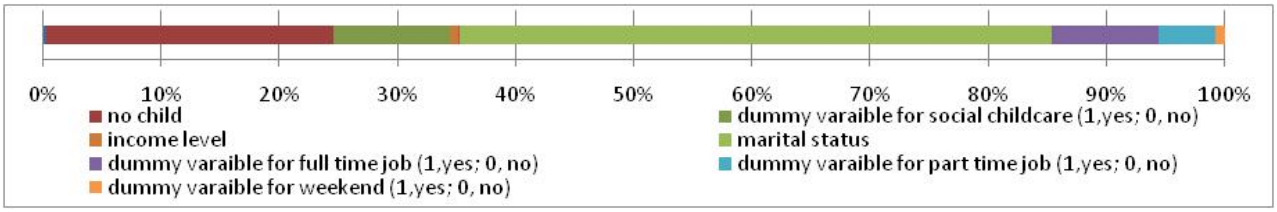

Fig.3 Proportion of variance for each explanatory variable

5. Conclusion

Applying time allocation model incorporating activity participation, this paper examined the influence of childcare on women's activity participation and corresponding time allocation based on the data Survey Time Use and Leisure Activities in Japan in 2006. Model estimation results confirmed the influence of childcare and the necessity of studying childcare issues in promoting women's participation in labor market in Japan. The model estimation results using the data in other time points will be presented in the conference.

References

Collins, L.: Working Women and Childcare Decisions, 1830-1850. *E-Journal of Leeds History First*, 1, 2004.

Hamilton, C. H.: Trends, Issues, and Implications: the Influence of Child Care Needs on the Employment of Women. *Paper presented at the Annual Meeting of the Mid-South Educational Research Association*, 1995.

Senda Y.: Influence of Childcare Resources on the Employment Continuity of Married Women: Focusing on Occupation and Birth Cohort. *Journal of Population Problems*, 58 (2), pp.2-21, 2002.

Hallman, K., Quisumbing, A. R., Ruel, M. T., and de la Briere, B.: Childcare and Work: Joint Decisions among Women in Poor Neighborhoods of Guatemala City. FCND Discussion Paper Brief 151, International Food Policy Research Institute (IFPRI), Washington, D.C., 2003.

Zhang, J., Timmermans, H. and Borgers, A.: A Model of Household Task Allocation and Time Use, *Transportation Research Part B: Methodological*, 39 (1), pp.81–95, 2005.

Lee, L.-F.: Generalized Econometric Models with Selectivity, *Econometrica,* 51 (2), pp.507-512, 1983.

Xu, L., Zhang, J., and Fujiwara, A.: Modeling the Interactions between Activity Participation and Time Use Behaviors over the Course of a Day, *Proceedings of the Eastern Asia Society for Transportation Studies*, 7, 2009. (In proceeding)