The Effect of Day Care Facilities on Fertility of Working Married Women

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Abstract
The main objective of this paper is to examine the effect of the availability of day care facilities evaluated by working married women in Japan on their sequential fertility behavior. For this purpose, one-factor random effects probit model based upon a continuous latent variable method is employed and analysis performed, using 1993-1996 panel data from the Japanese Panel Survey on Consumers. The empirical results show that the availability of day care facilities has a positive effect on the fertility behavior during the observed period. In short, the higher their availability, the higher probability of birth among working married women. Consequently, it is clear that the provision of day care facilities should be considered as a meaningful social policy to help working married women reconcile career with child rearing.

Keywords: day care facilities; fertility behavior; Japanese Panel Survey on Consumers; random effects probit model

Introduction
Day care centers in Japan have been defined mainly as social welfare facilities to provide nursery care to children who cannot be taken care of by their parents, who need to work all day. Day care centers in this sense have been playing an important role as a social service to support the child rearing of working married women. It is, however, rarely considered or examined whether the availability of day care centers affects the decision of working married women to give birth.

Child care has become a major policy issue in Japan. Based on the agreement of the Ministers of Education, Health and Welfare, Labor, and Construction, the “Basic Orientations to Assist Child-Raising” (known as ‘Angel Plan’) was formulated in December 1994, in order to encourage society as a whole to support child rearing in a comprehensive and systematic manner. Nonetheless, the total number of children a woman bears during her lifetime declined to 1.34 in 1999. In December 1999, the “Concrete Plan to Implement a Priority Measure for the Declining Birth Rate” (known as ‘New Angel Plan’) was formulated by the Ministers of Education, Health and Welfare, Labor, Home Affairs, Finance, and Construction in response to the declining birth rate. This plan aims to ease burden of child rearing for women and develop various counter measures against the declining birth rate. In spite of these plans, there are many children on the waiting list, who satisfy the conditions for entering a day care center but cannot be accommodated because of the shortage of space and manpower, especially in metropolitan areas such as Tokyo and Osaka. The number of such children reported was 39,545 as of 1 April 1998, according to the “Annual Reports on Health and Welfare 1998-1999: Social Security and National Life” by the Minister of Health and Welfare.

The motivation of this paper is twofold. One is to study how the availability of day care facilities affects the fertility decision of working married women. This is closely related to the issue of the role of public support for child rearing as a means of increasing the birth rate. The other is to contribute to the understanding of the interaction effect between income and educational attainment on the fertility behavior of working married women.

While many studies have examined the effects of child care costs and availability of informal care on married women’s employment and fertility, relatively few exist on the effect of the availability of day care
facilities on women’s fertility. For example, several studies have examined the relationship between child care costs and married women’s behavior such as labor supply (Gustafsson and Stafford 1992; Hopfer and Wisssoker 1992; Ribar 1995; Webster and White 1997; Nakamura and Ueda 1999). Some studies have examined the effects of the presence of care-providing members in the household and the availability of informal care in the local area on the labor supply of married women (Heckman 1974; Stolzenberg and Waite 1984; Leibowitz, Waite, and Witsberger 1988). These studies find that the employment behavior of married women is significantly influenced by variables that would be altered by child care policies such as provision of day care center, child care costs, and child care subsidies. Studies also have examined housing factors such as tenure and size of housing (Kojima 1993; Ishizaka and Qin 2000), and find the significant effect of these factors on fertility. Several studies have also examined the demand and supply of child care services (Blau 1992; Walker 1992; Segawa and Sadahiro 1996; Mocan 1997; Blau and Hagy 1998; Takeda 2000; Sakamoto and Umedu 2001).

However only a few studies exist on the effect of availability of day care facilities on women’s fertility behavior. To our knowledge, only Presser (1980) and Hirosima (1981) analyze factors including the availability of child care, but it is still limited to a descriptive and qualitative analysis. Blau and Robins (1989) examine the effect of child care costs on fertility behavior of married women. They find that the probability of birth declines significantly for nonemployed women, but not for employed women as child care costs rise.

In this paper both the individual and interaction effect of a wife’s annual taxable income and her educational attainment on fertility behavior are examined. The interaction effect between a wife’s income and education implies that the effect of a wife’s income on fertility behavior depends on the level of her education, or that the effect of a wife’s education on fertility behavior depends on the level of her income. The negative individual effect of a wife’s annual taxable income and the educational attainment of married women is agreed by most economists (Heckman 1981). State dependence implies that the past history of states occupied by an individual affects an individual’s current states. Unobserved heterogeneity implies that individuals differ in certain unobserved behavioral characteristics that cannot be included in the model but affect their probability of experiencing an event (e.g., propensities for birth). In this paper, our specification of sequential fertility decisions focuses only on unobserved heterogeneity as a component of the model error. We assume that the previous fertility behavior is not correlated to the present behavior and excludes the lagged fertility behavior from the model employed in empirical evidence concerning the impact of the provision of day care facilities on the fertility decision of working married women in Japan. We tested the hypothesis that the availability of day care facilities in their neighborhood would have a significant impact on the fertility behavior of working married women. We believe this is the first attempt to consider explicitly the effect of the availability of day care facilities on sequential fertility behavior. We also analyzed fertility behavior, firstly, including the interaction variable and, secondly, excluding it. To this end, one-factor random effects probit model based upon the continuous latent variable method is employed and estimated, using 1993-1996 panel data from the Japanese Panel Survey on Consumers.

The key parameter of interest in this paper is the coefficient of the availability of day care facilities. The marginal effect of the availability of day care facilities on the fertility decision of working married women is then calculated and the policy effectiveness of the provision of day care facilities is discussed based on these findings. Note that in this paper we analyze the sequential fertility decisions of working married women for each year rather than the completed fertility of married women.

The rest of this paper is organized as follows. In Section 2, the methodology employed, the specification of sequential fertility behavior, data, and determinants of fertility are explained. In Section 3, we estimate the effects of determinants on fertility. In Section 4, conclusions and implications of this research are drawn, and future research directions are suggested.

Methodology
Random effects probit model
Fertility behavior in this paper is modeled as life-cycle decisions, that is, as decisions regarding sequence of births rather than completed fertility. To this end, panel data that are repeated over-time on the same sample of individual cases are analyzed. The unique characteristics of panel data with repeatable events in contrast to static cross-sectional data is that it allows one to control unobserved individual characteristics. There are two major sources of serial correlation in the dependent variable over panel waves: state dependence and unobserved heterogeneity (Heckman 1981). State dependence implies that the past history of states occupied by an individual affects an individual’s current states. Unobserved heterogeneity implies that individuals differ in certain unobserved behavioral characteristics that cannot be included in the model but affect their probability of experiencing an event (e.g., propensities for birth). In this paper, our specification of sequential fertility decisions focuses only on unobserved heterogeneity as a component of the model error. We assume that the previous fertility behavior is not correlated to the present behavior and excludes the lagged fertility behavior from the model employed in
The random effects probit model underlying the empirical work in this paper is as proposed by Heckman and Willis (1976) and Heckman (1981), and a brief description follows. We assume that married women calculate a “marginal benefit minus marginal cost” based on the utilities of giving birth. Since marginal benefit or cost is obviously not observable, we model the difference between benefit and cost as an unobserved variable $y^*_t$ such as:

$$y^*_t = b'x_{i,t-1} + e_t, \quad i = 1, \ldots, N, \quad t = 1, \ldots, T_t,$$

$$e_t = v_t + u_t, \quad v_t \sim N(0, \sigma_v^2), \quad u_t \sim N(0, \sigma_u^2), \quad E(v_tu_t) = 0,$$

$$\rho = \text{COR}(e_t, e_s) = \sigma_v^2 / (\sigma_u^2 + \sigma_v^2),$$

$$y_t = \begin{cases} 1 & \text{if } y^*_t > 0 \\ 0 & \text{otherwise} \end{cases}$$

where $y^*_t$ is an unobservable latent variable for sequential fertility decisions of individual $i$ in time period $t$, $x_{i,t-1}$ is a vector of the lagged explanatory variables including the availability of day care facilities, that is, we explicitly consider a causal relationship that the lagged explanatory variables $x_{i,t-1}$ and not the present $x_{i,t}$ affects current dependent variable $y_t$; $b$ is a vector of parameters to be estimated. $e_t$ is the error term having two components; $v_t$ reflects any unobservable, persistent individual effects; $u_t$ is the purely random part of the error term; $v_t$ and $u_t$ are assumed to be normally, independently and identically distributed; $\rho$ represents the autocorrelation for any distinct panel ($t$ and $s$) and will be estimated; $y_t$ denotes the observed binary for whether or not a working married woman gives birth; $T_t$ indicates the number of repeated observations by individual $i$, as our panel data is unbalanced. In order to obtain a statistically acceptable sample size, the analysis is carried out using unbalanced panel data.

The estimation was done using the LIMDEP developed by Greene (1995). Full details on estimation may be found in Butler and Moffitt (1982) and Greene (2000, pp.837-839).

**Data**

The data source for this analysis is the Japanese Panel Survey on Consumers (JPSC). The JPSC is a nationally representative longitudinal survey that contains a wealth of demographic, income, expenditure, saving and labor supply information, conducted by the Institute of Household Economy (1995). The JPSC started in 1993 by using a mail questionnaire with a stratified two-stage sample of 1,500 women aged 24-34 on 1 October 1993, who have been surveyed periodically since then. The data available for our empirical analysis is from 1993 to 1996.

Since we are interested in the sequential fertility behavior of working married women, first of all only data for both married and continuously employed women (full or part-time) were selected during this period. However, information on the availability of day care facilities was only surveyed in 1993, hence those women who migrated after 1994 are deleted from the analysis because there is no information on the availability of day care facilities after 1994. Also, an important limitation of the survey is that information on place of residence was obtained only at three categorical values; metropolitan, urban, and rural areas. Having no information on the respondent’s residential area, we are not able to measure the level of provision of day care facilities directly as an objective availability indicator, hence it is difficult to analyze the level of provision of day care facilities (e.g., the number of places per child under the age of five in residential areas) as an objective policy variable of the fertility decision. Consequently, only the availability of day care facilities as evaluated by working married women is examined in this paper. After omitting observations with missing values, the resulting sample has information on 270 working married women over the period 1993-1996 (682 observations in total, due to unbalanced panel data the total sample size is not equal to three times the number of individuals). All results in this paper are conditional on this selection.

**Determinants of fertility behavior**

Definitions and descriptive statistics for the variables are given in Table 1. The dependent variable in this paper for fertility decision (Fertility) is a dichotomous indicator whether or not the working married woman gives birth in each year between 1994 and 1996; Fertility = 1 if she gives birth, 0 otherwise. Of the explanatory variables, availability of day care facilities (Availability) is constructed in the following scheme. Respondents were asked in 1993, “What do you think of day care facilities in your neighborhood?” and the possible responses are “1 very good, 2 good, 3 bad, 4 very bad, and 5 don’t know”. These numbers are rankings that are not quantitative but merely an ordering. Thus Availability is constructed as a dummy variable in the following fashion; 1 if “1 very good” and “2 good” indicating that day care facilities are available, 0 otherwise. As noted above, this variable is a subjective measure for the availability of day care facilities as evaluated by working married women. Our study uses only this measure of availability of day care facilities as a time-invariant variable that remains fixed over time. This variable and the presence of couples’ parent(s) (Parent = 1 if parent of couple is/are in the household) are expected to be positively related to fertility decision of working married women. These variables might increase the probability of the decision to give birth as well as fertility desires by reducing the burden of child rearing.

The effect of a spouse’s annual taxable income (SpouseInc) as a proxy for the household income is not clear. According to the quantity-quality approach developed by Becker (1960) and Becker and Lewis
(1973), a higher income of spouse may increase the demand for the number of children indicating quantity, because the costs of children can be covered. But on the other hand, a higher spouse’s income can also result in fewer children and a higher quality per child. Thus the net effect of a spouse’s income on the fertility decision relies on the relative strength of quantity to quality.

As mentioned in Section 1, we examined both the individual and interaction effect of a wife’s annual taxable income (WifeInc, in 10,000 yen) and her years of education completed (WifeEdu) on fertility behavior. Specifically we clarify the degree to which the effect of a wife’s income on the sequential fertility behavior of working married women is contingent on her education.

As controls, we also include the following because previous studies have shown that they are important determinants of fertility (see, for example, Montgomery and Trussell 1986). Wife’s age (Age) and age-squared term (Age2) are included for demographic reasons such as that the age pattern of natural fertility has a concave (inverse U) shape. That is, the decision to give birth tends to increase with age up to about age 30 or 35, after which it tends to level off or even decline. The number of children ever born (Kids) is generally considered negatively related to the fertility decision, the more the number of existing children. A dummy variable for residence (Urban = 1 if household lives in a metropolitan area or city; 0 otherwise) is also included in our analysis. Urban households are expected to have fewer children than their rural counterparts, since it cost less to rear children in rural areas, among others.

**Brief review for summary statistics**

Table 1 also provides descriptive statistics of these variables. Note that these variables change over time regardless of time-invariant variables like Availability, WifeEdu, and Urban because of the unbalanced panel data. The response variable, that is sequential fertility decisions, slightly decrease from 0.11% in 1994 to 0.07% in 1996. Thus, there is a slight decrease over time in the frequency of births among working married women probably as a result of their aging. The proportion of which the availability of day care facilities is high (Availability = 1) is about 71% during the observation period.

The presence of couples’ parents in the household (Parent = 1) slightly declines from 59% in 1993 to 54% in 1995. Both the spouse’s and wife’s income slightly increase over the three years; that is, 4.486 and 1.985 million yen in 1993 respectively but by 1995 had increased to 5.072 and 2.146 million yen respectively. Of the wife’s attributes the average education years is about 13, indicating college level. Married women were on average 30.86 years of age in 1993. The average number of children ever born in the household increases from 1.54 children in 1993 to 1.76 children in 1995. Lastly, in the sample there were

<table>
<thead>
<tr>
<th>Table 1. Variable definitions and summary statistics per year</th>
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<tbody>
<tr>
<td><strong>Variable</strong></td>
</tr>
<tr>
<td>Response variable</td>
</tr>
<tr>
<td>Fertility</td>
</tr>
<tr>
<td>Child rearing environment</td>
</tr>
<tr>
<td>Availability</td>
</tr>
<tr>
<td>Parent</td>
</tr>
<tr>
<td>Annual income</td>
</tr>
<tr>
<td>SpouseInc</td>
</tr>
<tr>
<td>WifeInc</td>
</tr>
<tr>
<td>Wife’s attributes</td>
</tr>
<tr>
<td>WifeEdu</td>
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<tr>
<td>Age</td>
</tr>
<tr>
<td>Age2</td>
</tr>
<tr>
<td>Interaction term</td>
</tr>
<tr>
<td>Kids</td>
</tr>
<tr>
<td>Urban</td>
</tr>
<tr>
<td>Sample size</td>
</tr>
</tbody>
</table>

*Observed from 1994 to 1996.*
*Bilateral observations are less than one hundred thousand yen.*
*Samples with twin-birth are excluded from the data.*
68% families living in urban areas in 1993 (Urban = 1) while the rest lived in rural areas.

**Estimation results and simulations**

Table 2 presents the estimated parameters of two competing models for working married women’s fertility behavior. The Individual Model includes all independent variables as individual effects, whereas the Interaction Model adds the interaction effect of a wife’s income and educational attainment to the Individual Model.

The Interaction Model tests the hypothesis proposed in this research that the effect of working wife’s income on fertility behavior depends on the wife’s educational attainment. The Likelihood-ratio test comparing the Interaction Model with the Individual Model yielded a chi-squared statistic of 8.26 with 1 degree of freedom (significant at 1% level), so the hypothesis that the coefficient of interaction variable in the Interaction Model is zero is rejected against the Individual Model. This result demonstrates that the interaction variable, WifeInc × WifeEdu, increases the statistical significance of the Interaction Model. The parameter estimate of the interaction effect in the Interaction Model is also significant at 1% with t-test, indicating that by not accounting for the interaction effect between a wife’s income and educational attainment, the misspecification for modeling of working married women’s fertility behavior may have occurred. Our hypothesis that the effect of a wife’s income on the fertility behavior of working married women is contingent on her educational attainment is empirically demonstrated. This means that the interaction effect between a wife’s income and educational attainment is an important determinant of fertility behavior, as well as their individual effects. From these results, we now discuss only the estimation results of the Interaction Model in Table 2. Note that the estimated autocorrelation \( \hat{\rho} \) of the error term \( e_t \) is zero so that we find no evidence of significant effect of unobserved heterogeneity for sequential fertility behavior. In other words, unobserved heterogeneity in our sample data is empirically unimportant in examining sequential fertility behavior and the estimation results are equal to those of the conventional probit model in the cross-section case. Similar result have been reported in Heckman and Walker (1990).

Of the list of explanatory variables, we are most interested in the effect of availability of day care facilities on the sequential fertility behavior of working married women. Based on results in Table 2, the availability of day care facilities (Availability) is statistically significant at the 10% level and is positively related to the sequential fertility behavior of working married women. In addition the presence of grandparent(s) (Parent) as an important part of the child rearing environment is positive and significant at 5% level. These results support the validity of our primary hypothesis that the availability of day care facilities in their neighborhood and the presence of grandparent(s) in the household will have a significant impact on the fertility behavior of working married women. In other words, the higher the availability of day care facilities or the presence of grandparent(s), the greater probability of births.

The effect of a spouse’s income on fertility is negative and this result is statistically significant at 5%. As a spouse’s income increases, a dual-income family is likely to have low fertility but higher quality support for children. We also find a negative and significant effect of the wife’s income and educational attainment on the fertility decision. The exact effect of each variable, however, is difficult to interpret directly because of the nesting of the interaction effect.

To clarify the interaction effect of the conditional probability, after allowing for the educational attainment of working married woman, is calculated and plotted in Figure 1. The educational attainment of working married women is divided into three categories such as university graduates (dash line), college graduates (dotted line), and high school graduate (solid line). The effect of a woman’s income over 12.1 years of education, e.g., university graduate, has a positive effect on the decision to have children.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Individual Model Coefficient (Standard error)</th>
<th>Interaction Model Coefficient (Standard error)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child rearing environment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Availability</td>
<td>0.3245* (0.178)</td>
<td>0.3133* (0.181)</td>
</tr>
<tr>
<td>Parent</td>
<td>0.3384** (0.164)</td>
<td>0.3452** (0.166)</td>
</tr>
<tr>
<td>Annual income</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SpouseInc</td>
<td>-0.0012** (0.001)</td>
<td>-0.0012** (0.001)</td>
</tr>
<tr>
<td>WifeInc</td>
<td>0.0015*** (0.001)</td>
<td>-0.0121** (0.005)</td>
</tr>
<tr>
<td>Woman’s attributes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WifeEdu</td>
<td>0.0445 (0.051)</td>
<td>-0.2109** (0.104)</td>
</tr>
<tr>
<td>Age</td>
<td>1.0305** (0.526)</td>
<td>1.1452** (0.536)</td>
</tr>
<tr>
<td>Age2</td>
<td>-0.0180** (0.009)</td>
<td>-0.0199** (0.009)</td>
</tr>
<tr>
<td>Interaction term</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WifeInc × WifeEdu</td>
<td>0.0010*** (0.0003)</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kids</td>
<td>-0.3668*** (0.097)</td>
<td>-0.3834*** (0.098)</td>
</tr>
<tr>
<td>Urban</td>
<td>0.0279 (0.172)</td>
<td>0.0653 (0.174)</td>
</tr>
<tr>
<td>Constant</td>
<td>-16.2128** (7.951)</td>
<td>-14.4830** (8.083)</td>
</tr>
<tr>
<td>**cLR testb (d.f.)</td>
<td>61.29*** (9)</td>
<td>69.55*** (10)</td>
</tr>
<tr>
<td>Total sample size (individuals)</td>
<td>682</td>
<td>270</td>
</tr>
</tbody>
</table>

\[ \hat{\rho} = \frac{\sigma^2_w}{\sigma^2_w + \sigma^2_e} \]  
\[ \text{Likelihood-ratio statistic} = -2(\log L_c - \log L_o). \]
\[ \text{Likelihood-ratio statistic} = -2(\log L_c - \log L_o) \text{ of Individual Model} - \log L_o \text{ of Interaction Model}. \]
\[ \text{Statistically significant at the 10% level.} \]
\[ \text{Statistically significant at the 5% level.} \]
\[ \text{Statistically significant at the 1% level.} \]
while that of women under 12.1 years of education, e.g., high school graduates, is negative but its slope is almost flat. These results imply that high income and well educated working married women are more likely to give birth, than low income and less educated working married women.

As expected, the wife’s age and age-squared are positive at the 5% significance level and negative at the same level respectively, showing an inverse U-shape. The number of children ever born has a negative and significant effect on the probability of having another child, indicating that increases in the existing children lowers the probability of another birth. Finally, the coefficient for dummy variable Urban is positive but not statistically significant.

To illustrate how our estimate of the availability of day care facilities affects the sequential fertility behavior of working married women, the marginal effects of the availability of day care facilities are evaluated by simulation. This is because unlike the linear regression model the nature of the nonlinear regression model such as a random effects model in this paper makes it difficult to see the implications of the results by direct inspection of the coefficients (Greene 2000, pp.816-818). The simulation is however, limited to the evaluation of a wife’s income and age. We present the following simulation results.

Figures 2 and 3 show how the effect of the availability of day care facilities can be interpreted as the difference in the probability of birth at a given point on the wife’s income and age, respectively. In Figure 2 the dash line is obtained by
predicting the probability of birth, as a sample means for the other independent variables, at Availability = 1. In the same way the dotted line is obtained at Availability = 0. The solid line represents the marginal effect of Availability that is calculated by the difference between the above two probability functions at each point of a wife’s income. Figure 2 shows that the effect of Availability on the probability of birth is far greater for working married women with high availability than for those with low availability at an increasing rate for all ranges of income. In other words, the marginal effects of the availability of day care facilities increase, as a wife’s income increases. These plots indicate that working married women with a higher availability of day care facilities in their neighborhood are more likely to give birth than those with a lower availability.

The probability of birth is similarly plotted as a function of the wife’s age for the Availability in Figure 3. As the figure indicates, the marginal effect of Availability (solid line) on fertility rates rises to a peak around 29 years of age, after which it tapers off. This result does suggest that the availability of day care facilities on the probability of birth has a maximal effect on working married women of approximately 29 years of age in our sample. In other words, working married women aged around 29 who have high availability are more likely to give birth than their counter parts in other age groups.

Conclusions

A analysis of this paper leads to the following two new findings. First, we have found that the availability of day care facilities evaluated by working married women has a significantly positive effect on the fertility behavior of working married women in Japan. The higher the availability, the higher the probability of birth among working married women. Consequently, the provision of day care facilities is an important factor motivating the fertility behavior of working married women who want to reconcile a career with child rearing. In other words, we can say that increasing day care provision is one possible way of encouraging Japanese working married women to have more children.

Secondly, our hypothesis that the effect of a wife’s income on the fertility behavior of working married women is contingent on her educational attainment is empirically demonstrated. That is, from the results of the random effects probit model including the interaction variable, it is clear that the interaction effect between a wife’s income and educational attainment is an important determinant of fertility behavior of working married women in Japan as well as those individual effects. Our estimate of the interaction variable indicates that high income and well educated working married women are more likely to give birth as the wife’s income increases, than low income and less educated working married women.

A limitation of our analysis is that we are not able to analyze the level of provision of day care facilities directly as an objective availability indicator, because information on the respondent’s residential address is not available due to considerations of privacy. Hence it would be worthwhile to reevaluate our results by employing some objective indicators of availability. In this study we focused on the fertility histories of working married women, ignoring possible interrelations between fertility and employment decisions. Also excluded in this study are private day care centers. Thus clarification of these issues is suggested as a future direction.

Acknowledgment

We wish to thank the Institute of Household Economy for permission to use the Japanese Panel Survey on Consumers and the anonymous referees for their comments and suggestions.

Endnotes

1We focused on working married women only because the effect of the availability of day care facilities on fertility behavior may be underestimated when non-working married women who are not eligible to use these facilities are included in the sample.

2There is a possible selection problem between the random effects probit model and random effects logit model. The random effects logit model however, does not permit much flexibility. See Maddala (1987, p.317). Also, there are a number of alternative specifications of binary response models with panel data. See for example, Hamerle and Ronning (1995).

3The effect of educational attainment on the probability of Fertility = 1 is computed using the result of the Interaction Model in Table 2. For example, the effect of university graduate (WifeEdu = 14) on the probability of a birth as a function of WifeInc is derived by

\[
\Pr(\text{Fertility} = 1 | \text{WifeEdu} = 14, \text{X}) = \Phi((-0.2109 \times 14) + (0.0010 \times 14 \times \text{WifeInc}) + \mathbf{b} \cdot \mathbf{x})
\]

where \( \Phi \) is the standard normal cumulative distribution function, \( \mathbf{b} \) and \( \mathbf{x} \) are the parameter estimates and the sample means of all explanatory variables excluding \( \text{WifeEdu} \) and \( \text{WifeInc} \) respectively. The probability of birth in Figs. 2 and 3 are calculated using the same formation.

4The marginal effect of a wife’s income (WifeInc) is derived by

\[
\frac{\partial \Pr(y_i = 1 | x_i)}{\partial \text{WifeInc}_i} = \frac{\partial \Phi(\mathbf{b} \cdot \mathbf{x})}{\partial \text{WifeInc}_i} = \phi(\mathbf{b} \cdot \mathbf{x}) (b_{\text{WifeInc}} + b_{\text{WifeInc} \times \text{WifeEdu}} \cdot \text{WifeEdu}_i)
\]

where \( \Phi(.) \) and \( \phi(.) \) denote the standard normal cumulative distribution function and the standard normal density function, respectively; \( \mathbf{b} \) is the parameter estimates; \( \mathbf{x} \) is the means of the explanatory variables excluding a wife’s educational attainment (WifeEdu). We can calculate the turning point of the effect of education by setting the marginal effect of income of
women to be zero as follows:

$$0 = \frac{\partial \Phi(b, \hat{\gamma})}{\partial \text{WifeInc}_{ci}} = \phi(b) \hat{\gamma}_i \left( \beta_{WifeInc} + \beta_{WifeInc \times WifeEdu} \cdot WifeEdu_{ci} \right).$$

(3)

References


