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# ESTIMATION OF A SIMULTANEOUS MODEL OF MARRIED WOMEN'S LABOR FORCE PARTICIPATION AND FERTILITY IN URBAN JAPAN


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## ABSTRACT

A strong and negative correlation between married women's labor force participation and fertility has been witnessed in Japan in past decades. Relative to empirical studies of a traditional single equation on female labor supply, there exist few econometric studies dealing explicitly with a possible interdependency between married women's labor supply and fertility behaviors in urban Japan.

Using the recently published 1980 Population Census of Japan, we have estimated a simultaneous-equation model of married women's labor force participation and fertility in urban Japan. Our model shows very satisfactory results to explain the negative correlation between those variables based on a method of 2SLS. Estimated labor supply elasticities for married women with respect to their fertility rates, wife's labor earnings, and male labor earnings are -0.67, 0.23, and -1.76 at the sample means, respectively. On the other hand, estimated elasticities of fertility with respect to married women's labor force participation and family income are -0.31 and 0.23, respectively. We find some of these elasticities for Japanese married women very comparable to those of married women in the United States.

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# Estimation of A Simultaneous Model of Married Women's Labor Force Participation and Fertility in Urban Japan

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## I. INTRODUCTION

In her recent papers on female labor force participation in Japan, M. Anne Hill (1982, 1983, and 1984) elucidates two important points: The first, a logit model explains Japanese female labor supply behavior for both grouped and disaggregated data well.
The second, a ratio of female employees to the total female population over 15 is the most suitable measurement for female labor force participation rate, rather than a commonly used measurement, the total female labor force divided by the total population in Japan. The second point reflects the fact that the proportion of female self-employed and family workers is nearly 36% of their total labor force in Japan in 1980.

The present paper extends the Hill's single-equation logit model (Hill 1984) to a simultaneuous-equation model of "married" women's labor supply and fertility in "urban" Japan.
The interdependency between married women's labor supply and their fertility has been emphasized in many studies of household behavior in the United States (Cain and Dooley 1976, Fleisher and Rhodes 1979a, Gregory et al. 1972, Link and Settle 1981, Schultz 1978, and Schultz 1974). The Hill's labor supply model is a traditional single equation. The model applied for female labor supply behavior in Japan would, therefore, yield biased and inconsistent

estimates of the structural parameters of their labor supply because married women as employees are almost 60% of total female employees in non-agricultural and forestry industries in recent years.[1]

Our paper diverges from the Hill's studies (1982 and 1984) in many respects. As mentioned earlier, we assume that two behavioral variables, i.e., married women's labor force participation and fertility, are simultaneously determined in the model. Our simultaneous-equation model is applied to the recently published 1980 Population Census of Japan while Hill (1982 and 1984) used the 1970 Census. We focus mainly on married women living in urban Japan whereas females without urban-rural differentials in Japan were studies in the Hill's papers (1982 and 1984).

There are advantages in our model, which uses cross-sectional market averages. As being illustrated by Cain and Dooley (1976) and Link and Settle (1981), differentiating married women from all females and also urban Japan from all Japan will represent a relatively homogeneous group of married women, which results in consistent estimates of the structural parameters in our model. Variations in tastes and transitory wages within a given geographical area can be averaged out. The averages of married women's labor supply and fertility may, therefore, be related to an observed average (permanent) wage (Mincer 1962).

As opposed to previous studies summarized by Hill (1982) on Japanese female labor supply, our estimates will circumvent a simultaneous equation bias by explicitly treating both married women's labor supply and fertility as endogenous variables in the model.[3] Last but not least, our estimates will permit comparisons with the estimates obtained in similar models in the United States, e.g., Cain and Dooley (1976).

The plan of this paper is as follows. Section II describes our statistical model and briefly mentions theoretical predictions of the data used in the model. Section III reports the empirical results. Finally, section IV gives a summary of the findings of this paper.

## II. THE SPECIFICATION OF MODEL

The central feature of our model is that the variables are cross-sectional market averages. The market averages of married women's labor force participation rates in prefectures have their values limited between zero and one. Based on a cumulative logistic probability function, the logit model of married women's labor force participation function is defined as follows (Pindyck and Rubinfeld 1976):

$$P_i = F(Y_i) = \frac{1}{1 + e^{-AX_i}} , \qquad \ldots\ldots (1)$$

where $P_i$ is the probability of being an employee for a married woman in the i-th prefecture; $F(\cdot)$ is the cumulative logistic probability function; and $X_i$ is a vector of right-hand-side variables.

On the assumption that the expected value of married women's labor force participation follows a logit function, the logit transformation probability $P_i$ in equation (1) is rewritten as follows (Neter and Wasserman 1974):

$$\log\left(\frac{P_i}{1 - P_i}\right) = a_0 + \sum_{j=1}^{m} a_{ji}X_{ji} + e_i^* , \qquad \ldots\ldots (2)$$

where $e_i^*$ is asymptotically normally distributed as total married women in urban areas of the i-th prefecture approach infinite (Hill 1984, and Neter and Wasserman 1974). The property for $e_i^*$ is defined as follows:

$$e_i^* \sim N\left(0, \frac{1}{TMW_i \cdot P_i \cdot (1-P_i)}\right), \quad \text{.....} \quad (3)$$

where $TMW_i$ is the total number of married women in urban areas in the i-th prefecture. In our empirical model, $P_i$ is substituted by the ratio of married women as employees to the total number of married women in cities ("Shi" in Japanese) of the i-th prefecture, whose ratio is denoted $MARLFP_i$.

Our simultaneous-equation model is defined as follows:

$$\log\left(\frac{MARLFP_i}{1 - MARLFP_i}\right) = a_0 + a_1 WIFINC_i + a_2 FAMINC_i + a_3 FERT80_i + a_4 UNEMPL_i + a_5 INDMIX_i + a_6 FEMEDU_i + a_7 KINDER_i + e_i^*, \quad \text{.....} \quad (4)$$

$$FERT80_i = b_0 + b_1 WIFINC_i + b_2 FAMINC_i + b_3 MARLFP_i + b_4 UNEMPL_i + b_5 INFANT_i + b_6 FEMEDU_i + e_i^{**}, \quad \text{.....} \quad (5)$$

where e's are structural disturbance terms and are assumed independent each other. Equations (4) and (5) are weighted by the square root of $TMW_i \cdot MARLFP_i \cdot (1-MARLFP_i)$ and the square root of $TMW_i$ to treat a common problem of hetroscedasticity for an analysis of cross-sectional grouped data, respectively.

Tables 1 and 2 present the definitions of the variables and their statistics in the above model, respectively. The theoretical predictions for the variables in each equation are extensively discussed in the literatures (Ben-Porath 1973, Cain and Dooley 1976, Cain and Weininger 1973, De Tray 1973, Fields 1976, Fleisher and Rhodes 1976 and 1979a, Gregory et al. 1972, Michael 1973, and Willis 1973). We breifly, therefore, outline the rationales.

In the logit labor supply equation (4) (hereafter, simply the labor supply equation), wife's expected market monthly income ($WIFINC_i$) will have a positive effect on married women's labor force participation because those women who are not initially in the labor force will be drawn into the labor markets as their expected wages increase, when the individual reservation wages vary (Ben-Porath 1973). Family income ($FAMINC_i$) and fertility ($FERT80_i$) are expected to have a negative effect on married women's labor force participation ($MARLFP_i$). $FAMINC_i$ excluding wife's monthly income reflects an income effect and hence increasing the reservation wages for married women. $FERT80_i$, which is the number of live births per 1,000 married women 15 years of age and over in cities in 1980 and is used as a proxy variable for a completed fertility of married women[4], will inhibit married women from joining labor markets because the bearing and raising of children is women's time-intensive household work. The effect of male unemployment rate ($UNEMPL_i$) is left open, although a negative discouraged worker effect seems to dominate a positive added worker effect in Japan (Furugori 1980) and in the United States (Bowen and Finegan 1969, Cain and Dooley 1976, Dooley 1982, Fields 1976, and Fleisher and Rhodes 1976 and 1979b). An industry mix variable ($INDMIX_i$) measures the relative importance of industries in each prefecture representing employment opportunities (Bowen and Finegan 1969, Cain and Dooley 1976, Fields 1976, and Fleisher and Rhodes 1976 and 1979b). As opposed to the industry mix variables defined by the above authors, we decided to use the male proportion of the national cities' employees in each industry as the weight rather than the female proportions.[5] We are rather interested to see if male employment opportunities exclude the opportunities from married women in the labor markets, although the former will conceivably exclude the employemnt opportunities from primary "single" women in Japan. Therefore, the expected sign of our $INDMIX_i$ will be positive if there exist spill-over employment opportunities for married women because of a gross complement for male employment in nature. Female educational attainment ($FEMEDU_i$) is expected to be negatively associated with married women's labor force participation since having more education will increase a shadow price of time (Shapiro and Shaw 1983). Also, education may increase the entry costs of married women's labor supply (Cogan 1981). The proportion of children under 6 in either nursery schools or kindergartens ($KINDER_i$) is expected to have a positive effect on $MARLFP_i$ and those facilities will provide a good substitute for the married women's own time-inputs into childrearing (Schultz 1978).

In the fertility equation (5), wife's income ($WIFINC_i$), married women's labor force participation rate ($MARLFP_i$), and female education ($FEMEDU_i$) are included as the proxy variables for the opportunity costs of bearing and rearing children (Link and Settle 1981, and Schultz 1974). All these are expected to have a negative effect on married women's fertility ($FERT80_i$). For example, the higher the level of married women's education the higher the value they will attach to nonmarket time, hence a higher opportunity cost of raising children. Besides the above line of hypothesis, $FEMEDU_i$ is also hypothesized as a proxy variable for effectiveness in birth control (Cain and Dooley 1976, Hashimoto 1974, and Schultz 1974). The male unemployment rate ($UNEMPL_i$) is included to reflect a structural phenomenon in labor markets for married women (Cain and Weininger 1973). Higher $UNEMPL_i$ will be associated with the lower opportunity cost for married women to raise children. The effect of infant mortality rate ($INFANT_i$) on married women's fertility is ambiguous, depending in part on the costs associated with infant deaths (both pecuniary and psychic costs) and the gross price elasticity of demand for surviving children (De Tray 1974).[6] $FERT80_i$ would fall as $INFANT_i$ decreases if the gross price elasticity is greater than one. The effect of family income excluding wife's income ($FAMINC_i$) on $FERT80_i$ is ambiguous since we don't include a proxy variable to control the quality of children[7] in the fertility equation. The famous debate on the "observed" vs. "pure" income elasticities of demand for numbers of children rests on the quantity-quality substitution of children in household production (Becker and Lewis 1973).

As concluding remarks on our model, both the labor supply and fertility equations are estimated by the Two-Stage Least Squares (2SLS).[8] In this model, the labor supply equation is exactly identified while the fertility equation is overidentified. Although the labor supply equation can be estimated by its reduced form, we did not attempt to estimate the reduced form because the left-hand-side of the labor supply equation is the log-odds ratio, which would result in a clumsy computation. The asymptotic t-statistics are, therefore, used to test the significance of the variables in the right-hand-side of both equations (Maddala 1974, and Fleisher and Rhodes 1976). Finally, the evaluation for the labor supply equation is made by its F-statistic rather than $R^2$ because the equation is the logit transformation of the probability of married women's labor force participation (Hill 1982).

TABLE 1

Definitions of Variables

| Variable Name | Definition |
|---|---|
| MARLFP | Proportion of married women 15 years of age and over in cities (all shi in Japanese) whose employment status is "mostly worked" in 1980. |
| FERT80 | Number of live births per 1,000 married women 15 years of age and over in cities in 1980. |
| WIFINC | Average monthly wife's income in cities with prefectural government in 1980 (in 1,000 yen), which is deflated by the cost-of-living of the cities. |
| FAMINC | Average monthly family receipts other than wife's monthly income in cities with prefectural government in 1980 (in 1,000 yen), which is deflated by the cost-of-living of the cities. |
| PRIC80 | Index of the cost-of-living of cities with prefectural government in 1980 (Japan = 100). |
| MALINC | Average monthly contractual cash earnings by male 15 years of age and over for all sizes of enterprise in industries in 1980 (in 1,000 yen), which is deflated by the cost-of-living of cities with prefectural government. |
| UNEMPL | Proportion of male unemployment 15 years of age and over in cities in 1980. |
| INDMIX | Index of industrial structure, defined as $\sum K_i IND_i$, where $K_i$ is the male proportion of the national cities' employees of industry i and $IND_i$ is the percentage of the cities' employees in industry i in 1980. |
| KINDER | Proportion of children under 6 years of age in cities, who go to either nursery schools or kindergartens in 1980. |
| CHILDR | Number of children aged between 1 and 5 per married woman in cities in 1980. |

(continued on next page)

TABLE 1 (continued)

| Variable Name | Definition |
|---|---|
| FEMEDU | Proportion of females 15 years of age and over in cities, who completed at least high school in 1980. |
| INFANT | Number of infant deaths per 1,000 live births in cities in 1979. |
| PRMARL | Proportion of married women 15 years of age and over in prefecture whose employment status is "mostly worked" in 1980. |
| PRFERT | Number of live births per 1,000 married women 15 years of age and over in prefecture in 1980. |
| PRUNEM | Proportion of total unemployment 15 years of age and over in prefecture in 1980. |
| PRINDM | Index of industrial structure, defined as $\sum P_i INDM_i$, where $P_i$ is the male proportion of the national prefectures' employees of industry i and $INDM_i$ is the percentage of the prefectures' employees in industry i in 1980. |
| PRKIND | Proportion of children under 6 years old in prefecture, who go to either nursery schools or kindergartens in 1980. |
| PRCHIL | Number of children under 6 per married woman in prefecture in 1980. |
| PRFEME | Proportion of females 15 years of age and over in prefecture, who completed at least high school in 1980. |
| PRINFA | Number of infant deaths per 1,000 live births in prefecture in 1979. |

TABLE 2

STATISTICS AND SOURCES

| Variable Name (Cities) | Mean | S.D. | Variable Name (Prefecture) | Mean | S.D. | Source |
|---|---|---|---|---|---|---|
| MARLFP | 0.247 | 0.067 | PRMARL | 0.264 | 0.070 | ... 1980 Population Census of Japan (1980 Census) |
| FERT80 | 55.17 | 6.205 | PRFERT | 53.04 | 6.408 | ... Vital Statistics 1980 and 1980 Census |
| WIFINC (in 1,000 yen) | 25.42 | 12.22 | | ...... | | ... Annual Report on the Family Income and Expenditure Survey 1980. |
| FAMINC (in 1,000 yen) | 437.7 | 62.75 | | ...... | | ... Annual Report on the FIES 1980. |
| | ...... | | MALINC (in 1,000 yen) | 180.0 | 13.59 | ... Year Book of Labor Statistics 1980. |
| UNEMPL | 0.030 | 0.012 | PRUNEM | 0.025 | 0.010 | ... 1980 Census. |
| INDMIX | 66.66 | 0.596 | PRINDM | 66.36 | 0.792 | ... 1980 Census. |
| KINDER | 0.383 | 0.054 | PRKIND | 0.425 | 0.046 | ... 1980 Census. |
| CHILDR | 0.307 | 0.031 | PRCHIL | 0.398 | 0.050 | ... 1980 Census. |
| FEMEDU | 0.503 | 0.062 | PRFEME | 0.465 | 0.071 | ... 1980 Census. |
| INFANT | 7.936 | 1.101 | PRINFA | 8.162 | 1.079 | ... Vital Statistics 1979. |
| PRIC80 | 101.0 | 2.348 | | ...... | | ... Japan Statistical Yearbook 1982 |

Note. S.D. is standard deviation. FIES represents Family Income and Expenditure Survey.

## III. EMPIRICAL RESULTS

The model of simultaneous equations (4) and (5) in the previous section was applied to the data for 47 "urban" prefectures in 1980 and also 47 prefectures with no urban-rural differentials for a comparative purpose. Those equations were estimated with weighted data by a method of two-stage least squares (2SLS). Table 3 reports the estimates of the structural coefficients for the labor supply and fertility equations for the urban data as does Table 4, but only the estimates of the labor supply for the data with no urban-rural differentials. The variables of wife's income ($WIFINC_i$), family income ($FAMINC_i$), and male earnings ($MALINC_i$) are deflated by the indexes of the cost of living in cities with prefectural government in 1980.

### 3-1. Labor Supply

The logit model of the married women's labor supply equation (Equation (1) in Table 3) is strongly supported by the large F-statistic (19.52) at the 1% significance level.

The estimated coefficient on the wife's income variable ($WIFINC_i$) is positive and statistically significant at the 1% significance level. To recover the partial derivative of $WIFINC_i$, we multiply the coefficient, 0.012, by 0.1860 (= 0.247x(1-0.247)), which results in about 0.002. The point estimate of elasticity of MARLFP with respect to WIFINC is about 0.23 at the sample mean. Our gross wage elasticity of urban married women's labor supply is almost half of Hill's estimate of all females', 0.44 (Hill 1984). Our smaller estimate might result from the fact that we use only married women employees while Hill uses all female employees. In general, a single female is more likely to be a paid-employee in labor markets than a married woman. Another possible explanation is that Hill's gross wage elasticity might be overestimated if a relevant fertility variable is significant in a female labor supply equation since the Hill equation does not include this fertility variable.[9]

Compared with gross wage elasticities for married women in the United States, our estimate is much smaller than those estimates by various authors in Keeley (1981). Keeley reports 1.28 for a mean of gross wage elasticities obtained by eleven different studies. In a similar simultaneous equations' context, Cain and Dooley (1976) reports 2.0 for the SMSA's data in the 1970 Census, while Fleisher and Rhodes (1979a) obtains 4.2 for the disaggregate data of the National Longitudinal Surveys and Link and Settle (1981) reports 0.40 (registered nurse) for the SMSA's data in the 1970 Census.[10] As a sort of explanation for the Japanese-American differentials in addition to the possible differences in tastes and, as an obvious reason, cultural backgrounds, if the labor supply curve is the cumulative distribution of subjective wages of individuals, the small gross wage elasticity of married women's labor supply in urban Japan can be reasonable. Since the response of groups with very low labor force participation rates to wages will be smaller than the response of groups with labor force participation rate close to 50 percent (Ben-Porath 1973). As listed in Table 2, the mean labor force participation rate for married women (employees only) in urban Japan is only about 25 percent in 1980.

The effect of family income variable ($FAMINC_i$) is significant but positive, whose sign is puzzling. We, therefore, attempted to re-estimate the model by using the variable of male average earnings in industries ($MALINC_i$) and report its result as Equation (4) in Table 3. The estimates coefficient turns out -0.013 and is statistically significant at the 1% significance level. The point estimate of income elasticity at the sample mean is about -1.762. Since the income elasticity for married women in the United States ranges from -2.1 to 0.58 (Keeley 1981) and the elasticity is -1.2 in Cain and Dooley (1976), our estimate of the income elasticity seems close to the lower (negative) boundary. We consider it reasonable for the strong negative effect on married women's labor supply because married women in urban Japan are typically secondary workers compensating the husband's income.[11]

The effect of the fertility variable ($FERT80_i$) is negative as expected and almost significant in Equation (1) in Table 3. This fertility variable becomes statistically significant when we estimated the labor supply equation by the method of Generalized Least Squares (GLS). The result of GLS, which is a result of the second stage,is reported as Equation (3) in Table 3. The point elasticity of MARLFP with respect to FERT80 is about -0.670 at the sample mean. Although the significance of the fertility variable is a little sensitive to the model specification, we certainly cannot negate the possibility to explain the strong negative correlation between married women's labor force participation and their fertility in past decades.

The variables of industry mix ($INDMIX_i$), female education ($FEMEDU_i$), and enrollment of children under 6 in nursery schools or kindergartens ($KINDER_i$) all are statistically significant at the 1% significance level. The strong positive effect of $INDMIX_i$ suggests the gross complementarity between male and married women employees in industries.[12] An increase in the level of education for married women, as hypothesized earlier, substantially reduces the probability of their joining labor markets as employees.[13] As far as $KINDER_i$ is concerned, the rapid increase in the numbers of nursery schools and kindergartens in past years, as often argued and published in Japanese government publications, seems to have encouraged married women to join labor markets (see those Japanese government publications in reference). The point estimate of elasticity of MARLFP with respect to KINDER is about 0.667 at the sample mean. We found this elasticity almost three times larger than the gross wage elasticity of MARLFP. The availability of nursery schools and kindergartens seems a very necessary condition for married women to participate in their labor markets.

For comparative purposes, we estimate the same simultaneous-equation model for prefectural data with no urban-rural differentials. The second stage results for prefectural data are reported as Equation (5) (logit equation) and Equation (6) (GLS equation) in Table 4. The variables of male earnings ($MALINC_i$), fertility in prefecture ($PRFERT_i$), and enrollment for children under 6 in nursery schools or kindergartens in prefecture ($PRKIND_i$) are significantly important in Equation (5). To recover those partical derivatives at the sample means, we multiply the estimated coefficients by 0.1943. The point elasticities at the sample means are are about -1.590, -0.625, and 0.470 for MALINC, PRFERT, and PRKIND, respectively. These elasticities are slightly smaller than those obtained from the urban data. The variable of wife's income ($WIFINC_i$) is significantly positive in GLS equation (6) in Table 4.

3-2. Fertility

Fertility rate is measured by the number of live births per 1,000 married women in 1980. This measurement is used as a proxy variable for a completed fertility of married women, although the children ever born per married woman is commonly used in the study on married women's fertility behavior. Our variable of fertility rate ($FERT80_i$) is, however, relatively satisfactory and the fertility equation (Equation (2) in Table 3) is statistically significant at the 5% significance level.

The variable of wife's income ($WIFINC_i$) is insignificant, although this variable is usually assumed to be one of the major opportunity costs for married women to raise children. Women's labor earnings are frequently found to be significant and negative in fertility equations for the United States, e.g., Cain and Dooley (1976), Cain and Weininger (1973), Link and Settle (1981), and Schultz (1974).

The coefficient of family income ($FAMINC_i$) is positive and statistically significant. The point estimate of income elasticity is about 0.230 at the sample mean. Our estimate is very close to the income elasticities for white women ever married ranging from 0.18 to 0.30 in Cain and Weininger (1973).

The variable of married women's labor force participation rate ($MARLFP_i$) is significantly negative in our simultaneous-equation model (-68.25 in Equation (2) in Table 3). A 10 percentage-point increase in average labor force participation rate for married women in urban Japan will result in a reduction of about 6.8 births per 1,000 married women. The point estimate of elasticity of FERT80 with respect to MARLFP is about -0.306 at the sample mean, whose value is very comparable to those values in Cain and Dooley (1976) ranging from -0.15 to -0.63. Our estimate, therefore, strongly supports the inclusion of married women's labor market activities in fertility equation and does not reject the possibility for a simultaneous relationship between married women's fertility and labor supply behaviors in household.

The variables of male unemployment rate ($UNEMPL_i$) and female education ($FEMEDU_i$) are also statistically significant and those signs are as expected. The strongly positive coefficient on $UNEMPL_i$ indicates that married women in urban Japan tend to have children when its opportunity costs are low. This finding is the same as the U.S. married women's fertility experience (Cain and Weininger 1973). On the other hand, the strong negative effect of $FEMEDU_i$ on $FERT80_i$ is consistent with the view that married women's level of education is a proxy variable for the importance of their knowledge of and access to birth control techniques (Cain and Weininger 1973). Also, the negative coefficient may reflect tastes of educated parents for other goods, e.g., quality of children, and the cost of parents' time in household production (Hashimoto 1974 and Schultz 1974).

In short, the results from our fertility equation indicate significant interactions between fertility and other socioeconomic variables such as married women's labor supply, family income, female education, and male unemployment. One of the most important findings is the significance of married women's labor force participation in our simultaneous-equation model. Another noteworthy finding is that the point estimates of elasticities at the sample means are very close to the elasticities found for the U.S. married women, e.g., the income elasticity of fertility (ours 0.23 compared to 0.18-0.30 in Cain and Weininger (1973) for the U.S.); and the elasticity of fertility with respect to married women's labor supply (ours -0.31 compared with -0.15 to -0.63 in Cain and Dooley (1976) for the U.S.). Our specification on the fertility equation is satisfactory but the relatively small R-square (0.286) and F-statistic (2.66) suggest the necessity to investigate other determinants on married women's fertility behavior in urban Japan.

TABLE 3

Empirical Results for Married Women's Labor Force Participation (Employees only) and Fertility

Urban Prefectural Data in 1980
The 2nd Stage's Results of 2SLS

| Independent Variable | Equation No. and Dependent Variable | | | |
|---|---|---|---|---|
| | (1)[a] log(P /(1-P )) | (2) FERT80 | (3) MARLFP | (4)[a] log(P /(1-P )) |
| Intercept | -10.77*** (-3.159) | 68.26*** (4.597) | -1.275** (-2.212) | -4.849 (-1.629) |
| WIFINC | 0.012*** (2.773) | 0.139 (0.992) | 0.002*** (2.986) | 0.006* (1.773) |
| FAMINC | 0.002** (2.587) | 0.029* (1.797) | 0.0003** (2.563) | --- |
| MALINC | --- | --- | --- | -0.013*** (-5.170) |
| FERT80 | -0.015 (-1.640) | --- | -0.003* (-1.825) | -0.010 (-1.385) |
| MARLFP | --- | -68.25* (-1.900) | --- | --- |
| UNEMPL | 3.390 (0.782) | 239.3*** (2.896) | 0.679 (0.913) | -4.619 (-1.459) |
| INDMIX | 0.142*** (3.012) | --- | 0.023*** (2.844) | 0.085** (2.142) |
| INFANT | --- | 0.227 (0.295) | --- | --- |
| FEMEDU | -1.943*** (-3.372) | -43.67** (-2.285) | -0.328*** (-3.245) | -0.098 (-0.185) |
| KINDER | 2.313*** (2.844) | --- | 0.386** (2.679) | 2.527*** (3.839) |
| F-statistic | 19.52 | 2.66 | 18.87 | 31.70 |
| $R^2$ | --- | 0.286 | 0.772 | --- |
| N | 47 | 47 | 47 | 47 |

(continued on next page)

TABLE 3 (continued)

[a]P represents MARLFP. Logit coefficients are reported.
To recover partial derivatives at the sample mean, multiply each logit coefficient by 0.1860.
Asymptotic t-statistics are reported in parentheses.
The F-statistics are significant at the 1 percent level for equations (1), (3), and (4), and at the 5 percent level for equation (2).
*** significant at $\alpha$ = 1%.
** significant at $\alpha$ = 5%.
* significant at $\alpha$ = 10%.

TABLE 4

Empirical Results for Married Women's Labor Force Participation (Employees only)

Prefectural Data in 1980

The 2nd Stage's Results of 2SLS

| Independent Variable | Equation No. and Dependent Variable (5)[a] log (LP/(1-LP)) | (6) PRMARL |
|---|---|---|
| Intercept | 1.779<br>(0.409) | 0.928<br>(1.192) |
| WIFINC | 0.005<br>(1.430) | 0.001**<br>(2.044) |
| MALINC | -0.012***<br>(-3.122) | -0.002***<br>(-2.962) |
| PRFERT | -0.016*<br>(-1.793) | -0.003**<br>(-2.064) |
| PRUNEM | -7.200<br>(-1.659) | -0.865<br>(-1.133) |
| PRINDM | 0.0008<br>(0.014) | -0.002<br>(-0.222) |
| PRFEME | -1.096<br>(-1.579) | -0.216*<br>(-1.788) |
| PRKIND | 1.501*<br>(1.740) | 0.218<br>(1.360) |
| F-statistic | 23.17 | 23.36 |
| $R^2$ | --- | 0.807 |
| N | 47 | 47 |

[a]LP represents proportion of married women 15 years of age and over in prefecture whose employment status is "mostly worked" in 1980 (PRMARL). Logit coefficients are reported. To recover partical derivates at the sample mean, multiply each coefficient by 0.1943.

(continued on next page)

TABLE 4 (continued)

Asymptotic t-statistics are reported in parentheses.
The F-statistics are significant at the 1 percent level for equations (5) and (6).

*** Significant at $\alpha$ = 1%.

** Significant at $\alpha$ = 5%.

* Significant at $\alpha$ = 10%.

## IV. SUMMARY

In this paper we have estimated a simultaneous-equation model of married women's labor force participation and fertility in urban Japan, using the prefectural data in the 1980 Population Census of Japan. Among the few studies done on the above issue, we find that there is a significant interdependency between married women's labor supply and fertility behaviors based on the estimation method of 2SLS. Our model seems very satisfactory to explain the strong and negative correlation between married women's labor force participation and fertility in urban Japan.

Labor supply elasticities of married women in urban Japan with respect to their fertility rate, wife's labor earnings, and male labor earnings are -0.67, 0.23, and -1.76 at the sample means, respectively. On the other hand, elasticities of fertility with respect to married women's labor force participation and family income are -0.31 and 0.23 at the sample means, respectively. These estimated elasticities for Japanese married women look very comparable to those of married women in the United States.

# FOOTNOTES

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[1]Female employees in non-agricultural and forestry industries by marital status are as follows:

| Year | Total | Never Married | Married | Widowed and Divorced |
|---|---|---|---|---|
| 1962 | 100% | 55.2% | 32.7% | 12.0% |
| 1965 | 100% | 50.3 | 38.6 | 11.1 |
| 1970 | 100 | 48.3 | 41.4 | 10.3 |
| 1975 | 100 | 38.0 | 51.3 | 10.8 |
| 1980 | 100 | 32.5 | 57.4 | 10.0 |
| 1981 | 100 | 32.1 | 58.0 | 9.8 |

Source: Labor Force Survey. Office of the Prime Minister, (Takahashi 1983).

[2]Hill (1983) studies married women the ages of 20 and 59 living in the Tokyo Metropolitan Area. In the study on married women's labor supply, she applied a trichotomous logit model to a 1975 survey data of women in the Metropolitan area and used Heckman's estimation procedures for sample selection bias in the labor supply model.

[3]Hamilton (1979) estimated a similar model of simultaneous equations applied to the 1960 Population Census of Japan. Female labor force participation was negative and significant in the fertility equation and the variable of children ever born was positive but insignificant in the labor supply equation. Average number of children ever born to ever married women were obtained from the data of 1970 Census.

[4]Our measurement for married women's fertility rate is, therefore, a poor proxy variable. The number of children ever born to married women are no longer listed in the 1980 Population Census of Japan.

[5]The definitions of the industry mix variable is listed in Table 1. The variable is constructed by using these industries: agriculture, forestry and hunting, fishery and aquaculture, mining, construction, manufacturing, wholesale and retail trade, finance and insurance, real estate, transportation and communication, utilities (electricity, water and steam), services, and government.

[6]O'Hara (1975) theoretically shows that a mortality decline will induce parents to choose a smaller number of children if the substitution of quality for quantity (numbers) of children is sufficiently great to outweigh the tendency to substitute quality for other goods.

[7]De Tray (1973) uses public school expenditures per child in dollars per county in the United States as a proxy variable for quality per child.

[8]In the first stage, married women's labor force participation rate and fertility rate are regressed on the exogenous variables stated above and number of children per married woman. We, however, decided not to include the variable of number of children per married women as one of the explanatory variables in the second-stage equations although the variable is common and often used in these studies. The reason is that the number of children aged between 1 and 6 per married woman are strongly and positively associated with our fertility variable, i.e., the number of live births per 1,000 married women. We tend to consider that this strong correlation might result from the secular trend rather than a behavioral relationship between fertility and surviving children.

[9]Hill (1984) also includes these following variables in the model: male wage rate, non-wage income, children under 5 per married woman, and that fraction of the total labor force, employed in agriculture.

[10]These estimated are obtained from the data of white married women.

[11]Hill (1984) reports -0.52 for the income elasticity for female employees in Japan.

[12]This complementarity may not necessarily indicate the relationship within a given firm of a typical industry but, rather reveal the relationship in different sized firms in a given industry. Married women are usually employed in small sized firms, whose products are in turn used in a larger firm where a major proportion of the employees are male.

[13]Using the data from the National Longitudinal Surveys of work experience, Shapiro and Shaw (1983) also found a strong negative effect of married women's years of education on the probability of their joining labor markets. The estimate of educational attainment in their model explains about 17 - 28% of the observed change in white married women's labor force participation rate from 1967 to 1978.

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