Title	An econometric analysis of the labor supply of married females in Japan : a model of the choice betweenpart-time and full-time employment opportunities
Sub Title	
Author	樋口, 美雄(Higuchi, Yoshio) Matsuno, Kazuhiko
Publisher	Keio Economic Observatory (Sangyo Kenkyujo), Keio University
Publication year	1985
Jtitle	Keio Economic Observatory occasional paper. E No.3 (1985. 5)
JaLC DOI	
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Notes	
Genre	Technical Report
URL	https://koara.lib.keio.ac.jp/xoonips/modules/xoonips/detail.php?koara_id=AA10818580-00000003-0001

KEIO ECONOMIC OBSERVATORY
OCCASIONAL PAPER

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1. Introduction

The purposes of this study are to construct a labor supply model for wives of employee households facing part-time and full-time employment opportunities, and to carry an empirical test using Japanese micro data files of <u>the Basic Survey of Employment Structure</u> for the two years 1974 and 1977. The study is characterized by three points: (1) We focus our attention primarily on the labor supply behavior of married females to whom several employment opportunities are open. (2) Our model describes supplier's behavior exhibited in the decision to accept or reject employment opportunities. (3)Employment opportunities are classified according to their working hours, such as full-time work and part-time work.

(1) In most industrialized countries, for example the U.S. U.K. and France, a rapid increase in women's labor force participation ratio has been observed since the 1960's. Compared with those countries, however, a peculiarity appeared in Japan in the U-shaped trend of the aggregate women's labor force participation rate during the years from 1960 to 1980. In Table 1, we see that the women's participation ratio has actually declined during the years 1960 through 1975. The declining trend then changed into an increasing trend after 1976, and the increasing women's labor force participation rate is still prevalent in Japan at this time.

This difference between Japan and the other industrialized countries can be well understood if we divide the Japanese female labor force into two different categories: the one category consisting of household-based workers(self-employed workers and home handicraft and family workers), the other consisting of paid employees. These two categories showed different movements during the process of Japanese economic growth. The U-shaped peculiarity is thought of as combined movements of the decreasing household(-based) workers and the increasing paid employees.

Japan experienced unrivalled economic growth during the period before the first oil crisis of 1973. Economic growth caused a drastic chage in the employment structure and vice versa. At the beginning of the economic growth, a large proportion of workers were household-based workers in cottage industries and agriculture. For instance, in 1960 59.2% of female workers were self employed, home handicraft, or unpaid family workers. During economic growth this figure dropped rapidly, reaching 40.2% in 1975. This is a common fact of economic development. At the same time the number of female employees has gradually been increasing. During the time before the first oil crisis, however, the shrinkage of the labor force based on the farm and in the household dominated the rise of paid employment in the modern sectors. Accordingly, the aggregate women's labor force rate showed a decline from 54.4% in 1960 to 45.7% in 1975. This is the downward facet of the U-shaped trend, and the upward trend then follows. We may think of two influences of the oil crisis on the Japanese female participation ratio. One is that the oil crisis slowed the decline of household-based workers. The other is that the crisis accelerated the growth rate of employees. These two influences combined into the fact that the aggregate women's labor force rate has continued to increase since the year 1975.

In this way, the two categories showed quite different movements during Japanese economic growth. Therefore when we analyze the labor supply mechanism, these two types of job status must be distinguished. Otherwise the analysis will produce a biased conclusion. We therefore confine ourselves to the study of labor supply defined a employment outside the home. And we leave aside labor supply such as self-employment, home handicraft, and unpaid family workers, for the mechanism of choice between labor supply in household and that towards the market is still ambiguous.

(2) It is more difficult for employees than for self-employed workers to select their own working hours. We can imagine psychological and institutional pressures which make it difficult for employees to adjust working hours to their optimal ones for a given wage rate. The actual working hours in a day or a week are practically determined by the firm. The employment term is given not only by a wage rate but by a combination of wage rate and assigned working hours to which the employees are subject. Therefore suppliers cannot adjust their hours of work for a particular employment term. If several employment opportunities having fixed wage rate and assigned working hours are available in

the market, then suppliers may be able to select one among them.(Obi (1983)) In addition, from our previous analysis concerning the optimal working hours, by using Japanese yearly working hours data, it is clear that there is not as large a range of working hours in Japan as in the U.S. (Higuchi and Hayami(1984)). Furthermore, even if there might be a large variety of working hours which are assigned by firms, the turn-over cost in Japan is more expensive than that in the U.S. Most Japanese firms have a seniority wage system. In this system, the length of continuous service in a firm is influential in wage determination. If an employee switches to another job in order to adjust his working hours to the optimum, he must be ready for a large decrease in his wage. In Japan the turn-over rate is very low. We can say that it is not proper in Japan to accept the model where a supplier selects his optimal working hours freely without paying regard to turn-over cost. Consequently we set up a labor supply model of the framework where a wife makes a decision as to whether she accepts an offered employment opportunity or refuses it.

(3) As shown in Table 2, the number of part-time workers has increased remarkably under the circumstances where the employee participation rate was accelerating. The percentage of female non-agricultural employees whose working hours are less than 35 hours per week rose from 8% in 1960 to 20% in 1983. We present the model to clarify the mechanism of suppliers' choice between part-time and full-time employment. One may also note that the bulk of "part-

time" workers in Japan work more or less regularly and their work pattern is not all that different from full-time workers. So we assume that the working hours of a part-time job is assigned by the employer. In addition to these types of employment, suppliers can choose not to work in the market. The model demonstrates wives behavior concerning the choice among the three alternatives.

2 Theoretical Formulation

2.1 We will consider the labor supply behavior of wives to whom several employment opportunities are open. We consider in particular the case where two types of employment opportunities are offered on the firm-side. In view of the present state of the labor market with increasing participation by part-time workers, we assume that employment opportunities are classified into two classes of full-time employment and part-time employment. Wives are assumed to choose one of the two types of employment opportunities or to choose no employment. Therefore wives have three alternative options, which we call the full-time employment option, the part-time employment option, and the no-market work option. Our model based on the income-leisure preference describe wives' labor supply behavior in this choice situation.

The above formulation implies discrete choice behavior. This is the basic presumption of our model. The wage rates of part-time and full-time jobs are different. In most cases, it is observed that the former is lower than the latter. There are two options which are specified pairs of working time and wage rate. We introduce into the model an institutional factor that the employment opportunity is offered to the supplier with a fixed wage rate and assigned working hours. This is contrary to the neo-classical framework where workers freely choose the optimal length of time to work under a fixed wage rate. In the present model, the worker can only accept or reject a particular employment opportunity, and if several opportunities are offered then the worker can choose one of them taking into account utility maximization.

2.2 Denoting household income by X and leisure hours by Λ, the income-leisure prefernce of the household is presented by a utility indicator $\omega(X, \Lambda)$. To make an empirical test possible, we adopt the utility indicator of quadratic form in income and leisure hours,

$$\omega(X, \Lambda) = \frac{1}{2}\gamma_1 X^2 + \gamma_2 X + \gamma_3 X\Lambda + \overline{\gamma}_4 \Lambda + \frac{1}{2}\gamma_5 \Lambda^2 \quad (2.1)$$

Here the household income X consists of guaranteed income I, which may be husband's income and/or property income, and of wives' income, which is zero when the wife accepts the no-market work option. And the leisure hours is the total dispensable hours T minus wive's labor hours which is zero if the wife accepts the no-market work option. The γ's are parameters characterizing the indifference curve.

We observe that wives's labor supply behavior results in different decisions even if they are considered as being in the same condition. That is, within a group of wives facing similar employment opportunities and having equal husband's income, some wives choose employment opportunity and some wives do not work in the market. To describe this variation of wives' behavior, we introduce into the model the stochastic nature of the income-leisure preferences. For this purpose we regard the $\bar{\gamma}_4$ as a random variable reflecting the variation of household preferences. Different households are assumed to have different values of $\bar{\gamma}_4$ We specify that $\bar{\gamma}_4$ is distributed as normal with mean γ_4 and variance 6^2,

$$(2.2) \qquad \bar{\gamma}_4 \sim N(\gamma_4\ ,\ 6^2).$$

The "structural" parameters γ_1, γ_2, γ_3, γ_4, γ_5, 6 are final objects of our econometric inference, while the "reduced form" parameters, which will appear later (2.29) as some combinations of the structural parameters, can be intermediate objects.

The firms offer the two types of employment opportunities, and their employment terms are indicated by their wage rate and hours of working. For the full-time employment option, the employment term is denoted by a combination of wage rate w_1 and working hours h_1. For the part-time employment option, the employment term is denoted by a combination of the wage rate w_2 and working hours h_2 For the no-market work option, we use the convention of denoting its wage rate and working hours by $w_0=0$ and $h_0=0$ respectively. We set an inequality $h_1 > h_2$ to mean that the full-time employment option has longer hours of work.

In the empirical test which follows, we identify full-time employment as 35 hours or longer during a normal week, and part-time employment as less than 35 hours. For the wage rates, we see from our data that $w_1 > w_2$. But this relationship between W_1 and W_2, is not always necessary for our model to be formally valid.

The households have three alternative options which are presented by pairs of variables (w_1, h_1), (w_2, h_2) and (w_0, h_0). Again, the household is not assumed to have a possibility of selecting its optimal hours of work from a continuous range of hours. Instead, our model assumes that the household chooses one of the three alternative options depending on which yields maximum utility. Therefore, we will examine which one of the options gives the maximum. The choice of the household depends on the guarantted income I, the values of the wage rates, and the assigned working hours. These variables, I, w_1, h_1, w_2, h_2, as well as T constitute a set of exogenous variables for the model. A set (population) of households faces these exogenous variables in common. The stochastic variable $\overline{\gamma}_4$, which is specific to each household, is also a determining factor of the household's decision.

In Fig. 1 the three options of full-time employment, part-time employment and the no-market work option are illustrated as points a, b, and c respectively. Given the values of the exogenous variables, the shape of the indifference curve determines the utility maximizing point. For the shape of the curve depends on the value of $\overline{\gamma}_4$ that each household has. In Figs. 2, 3 and 4, we present different shapes of the indifference curve, and they correspond respectively to three cases where the points c, b, and a give the maximum utility. A household which has the value of $\overline{\gamma}_4$ giving the indifference curve of Fig 2, chooses the utility maximizing point c or the no-market work option. Similarly, a household in Fig. 3 chooses point b or the part-time employment option. And a household in Fig. 4 chooses point a or the full-time employment option.

2.3 From the graphical illustration, we turn to an analytical discussion, which determines the option that a particular household chooses, and derives the probability that a particular option is chosen by a set of households. For this, consider a household having a specific value of $\overline{\gamma}_4$.

If this household chooses the full-time employment option, it must hold that utility at point a is greater than that at points b and c, i. e. ,

(2.3) $$\omega(I+h_1w_1,\ T-h_1) > \omega(I+h_2w_2,\ T-h_2),$$

(2.4) $$\omega(I+h_1w_1,\ T-h_1) > \omega(I,\ T).$$

Or, if the inequalities (2.3) and (2.4) both hold, then the household chooses the point a or the full-time employment option. By using the specification of the utility indicator (2.1), we solve the inequalities in $\overline{\gamma}_4$, to obtain

(2.5) $$\overline{\gamma}_4<(I(m-n)+(i-j))/(h_1-h_2),$$

(2.6) $$\overline{\gamma}_4<(Im+i)/h_1,$$

where

$$m=h_1(\gamma_1 w_1-\gamma_3),\ n=h_2(\gamma_1 w_2-\gamma_3),$$

(2.7) $$i=\frac{1}{2}\gamma_1 h_1^2 w_1^2+\gamma_2 h_1 w_1+\gamma_3 h_1 w_1(T-h_1)-\gamma_5 h_1(T-\frac{1}{2}h_1),$$

$$j=\frac{1}{2}\gamma_1 h_2^2 w_2^2+\gamma_2 h_2 w_2+\gamma_3 h_2 w_2(T-h_2)-\gamma_5 h_2(T-\frac{1}{2}h_2).$$

We see that a household having the value of $\overline{\gamma}_4$ which satisfies (2.5) and (2.6) chooses full-time employment. We denote the right hand sides of (2.5) and (2.6) by A and B respectively.

In a similar way, for a household choosing part-time work, it must hold that

(2.8) $$\omega(I+h_2 w_2,\ T-h_2)>\omega(I+h_1 w_1,\ T-h_1),$$

(2.9) $$\omega(I+h_2 w_2,\ T-h_2)>\omega(I,\ T),$$

or equivalently that

(2.10) $$\overline{\gamma}_4>A,$$

(2.11) $$\overline{\gamma}_4<(In+j)/h_2.$$

we denote the right hand side of (2.11) by C. If a household has $\overline{\gamma}_4$ satisfying (2.10) and (2.11), then the household chooses the part-time employment option. Similarly again, for a household choosing the no-market work option, we have

(2.12) $\omega(I, T) > \omega(I+h_1w_1, T-h_1)$,

(2.13) $\omega(I, T) > \omega(I+h_2w_2, T-h_2)$,

or the equivalent inequalities

(2.14) $\overline{\gamma}_4 > B$,

(2.15) $\overline{\gamma}_4 > C$.

Conversely, a household which has $\overline{\gamma}_4$ satisfying (2.14) and (2.15) chooses the no-market work option. In this way, the choice of households depends on the value of $\overline{\gamma}_4$. These are considerations of the behavior of a single household with a specific value of $\overline{\gamma}_4$.

We then consider the behavior of households as a whole. And the question will be what proportion of a set of households chooses a particular option. To begin, we obtain the equations, from the definitions of A, B and C,

(2.16) $A-B=\{(Im+i)h_2-(In+j)h_1\}/h_1(h_1-h_2)$,

$B-C=\{(Im+i)h_2-(In+j)h_1\}/h_1h_2$

Since h_1-h_2 is positive and the same expression appears in the brackets of both equations, we find that the sign of (A-B) and the sign of (B-C) are the same. Therefore, we have two possible relationships between A, B and C,

(2.17) case 1 $A \geqq B \geqq C$,

case 2 $A < B < C$,

irrespective of the values of exogenous variables and the structural parameters included in A, B and C.

Suppose for the time being that the case 1, $A \geqq B \geqq C$, holds; then there is no $\overline{\gamma}_4$ such that the inequalities (2.10) and (2.11) are satisfied simultaneously. Therefore there cannot theoretically exist any household choosing the part-time employment option. We, however, actually observe the existence of households working part-time. So we cannot maintain that case 1 holds in reality, and we proceed with the discussion under the condition of case 2.

Under case 2, we can find, within the range of $\overline{\gamma}_4$-distribution, a value of $\overline{\gamma}_4$ satisfying (2.5) and (2.6), another value of $\overline{\gamma}_4$ satisfying (2.10) and (2.11), and still another value of $\overline{\gamma}_4$ satisfying (2.14) and (2.15): Within the range of the distribution of $\overline{\gamma}_4$, we take a value of $\overline{\gamma}_4$ such that

(2.18) $\overline{\gamma}_4 < A$.

For this value, we see that

(2.19) $\overline{\gamma}_4 < B$ and $\overline{\gamma}_4 < A$,

under case2, i. e. , the inequalities (2.5) and (2.6) are satisfied. Therefore a group of households, which have $\overline{\gamma}_4$ less than A, chooses the full-time employment option. Next we take, from the range of distribution,

(2.20) $A < \overline{\gamma}_4 < C$.

Then we see that, under case 2,

(2.21) $\overline{\gamma}_4 > A$ and $\overline{\gamma}_4 < C$.

Therefore a group of households which has $\overline{\gamma}_4$ satisfying (2.20) will choose the part-time employment option. Similarly, we take a value of $\overline{\gamma}_4$such that

(2.22) $C < \overline{\gamma}_4$.

Then we have, under case 2,

(2.23) $$B < \bar{\gamma}_4 \text{ and } \bar{\gamma}_4 < C .$$

Households which have $\bar{\gamma}_4$ satisfying (2.22) will choose the no-market work option. For households having $\bar{\gamma}_4$ equal to A, full-time employment and part-time employment are indifferent. But this probability is zero under the continuous distribution. A similar argument applies when $\bar{\gamma}_4$ is equal to C.

We now define the probabilities P_1, P_2 and P_0 such that a particular household chooses full-time work, part-time work or no-market work respectively. In other words, P_1, for instance, is the probability that a certain household drawn from the population is a household choosing full-time work.

From the previous discussion, we obtain

(2.24)
$$P_1 = \int_{\infty}^{A} f(\bar{\gamma}_4)\, d\bar{\gamma}_4,$$
$$P_2 = \int_{A}^{C} f(\bar{\gamma}_4)\, d\bar{\gamma}_4,$$
$$P_0 = \int_{C}^{\infty} f(\bar{\gamma}_4)\, d\bar{\gamma}_4,$$

where $f(\bar{\gamma}_4)$ is the probability density function of $\bar{\gamma}_4$. Using the normal specification (2.2), we can write

(2.25)
$$P_1 = \int_{\infty}^{y_1} \phi(X)dx,$$
$$P_2 = \int_{y_1}^{y_0} \phi(X)dx,$$
$$P_t = \int_{y_0}^{\infty} \phi(X)dx,$$

where

(2.26)
$$y_1 = (A - \gamma_4) / б$$
$$y_0 = (C - \gamma_4) / б$$
$$\phi(x) = \exp - \frac{1}{2} x^2 / \sqrt{2 \pi}$$

Based on the utility maximization principle, we obtain the solution which shows that the probabilities P_1, P_2 and P_0 are determined by thresholds y_1 and y_0 which are explicit functions of the set of the exogenous variables and of the structural parameters, as shown in Fig 5.

From the definition (2.7) of m, n, i, and j, and from the definition of A and C, we write out (2.26) in the form

(2.27) $$\underset{\sim}{y} = \begin{bmatrix} y_0 \\ y_1 \end{bmatrix} = \underset{\sim}{Z}\,\underset{\sim}{\pi}.$$

Here

(2.28) $$\underset{\sim}{Z} = \begin{bmatrix} 1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1 \end{bmatrix},$$

$$\underset{\sim}{\pi}' = (\pi_{00}, \pi_{01}, \pi_{10}, \pi_{11}),$$

and furthermore the reduced form parameter is given by

(2.29) $$\underset{\sim}{\pi} = \underset{\sim}{X}\,\underset{\sim}{\theta},$$

where the structural parameter $\underset{\sim}{\theta}$ and the matrix $\underset{\sim}{X}$ are given as

$$\underset{\sim}{\theta}' = (\gamma_1/\delta,\ \gamma_2/\delta,\ \gamma_3/\delta,\ \gamma_4/\delta,\ \gamma_5/\delta),$$

(2.30) $$\underset{\sim}{X} = \begin{pmatrix} \frac{1}{2}h_2w_2^2 & w_2 & w_2(T-h_2) & -1 & \frac{1}{2}h_2 - T \\ w_2 & 0 & -1 & 0 & 0 \\ \dfrac{h_1^2w_1^2 - h_2^2w_2^2}{2(h_1-h_2)} & \dfrac{h_1w_1 - h_2w_2}{h_1-h_2} & \dfrac{h_1w_1(T-h_1) - h_2w_2(T-h_2)}{h_1-h_2} & -1 & \dfrac{h_1+h_2}{2} - T \\ \dfrac{h_1w_1 - h_2w_2}{h_1-h_2} & 0 & -1 & 0 & 0 \end{pmatrix}$$

We can rewrite $\underset{\sim}{y}$ in the form, from (2.29) ,

(2.31) $$\underset{\sim}{y} = \underset{\sim}{Z}\underset{\sim}{\beta}$$

where $\underset{\sim}{Z}=\underset{\sim}{Z}\underset{\sim}{X}$. The equation (2.27) corresponds to the estimation of $\underset{\sim}{\pi}$, and the equation (2.31) corresponds to the estimation of $\underset{\sim}{\beta}$.

From (2.25), we obtain

(2.32)
$$\partial P_0/\partial I=-\phi(y_0)\pi_{01},$$
$$\partial P_1/\partial I=\phi(y_1)\pi_{11},$$
$$\partial P_2/\partial I=\phi(y_0)\pi_{01}-0(y_1)\pi_{11}.$$

Since ϕ is the normal density function and positive, we see that

(2.33) $$\partial P_0/\partial I>0 \quad \text{or} \quad \partial(P_1+P_2)/\partial I<0,$$
$$\partial P_1/\partial I<0,$$

if $\pi_{01}<0$, and $\pi_{11}<0$, respectively. Therefore, the effect of increasing I to the labor supply probabilities P_0, P_1 , and P_2 depends on the parameters π_{01} and π_{11}. Recalling Douglas Law of labor supply which says that husband's income affects wife's labor supply negatively $\partial P_0/\partial I>0$, it is interesting to see whether the estimated values of the parameters are of negative magnitude.

2.4 The model presented above is subject to empirical implementation. Our empirical test is twofold with respect to the data used; one using cross-sectional data ranging over households where the exogenous variables w_1, w_2, h_1 and h_2 for instance, in the matrix $\underset{\sim}{X}$, are considered to be constant and the guaranteed income I varies over the households, the other using pooled data consisting of sets of cross sectional data at two time points, where the exogenous variables at the two time points are different. In the cross sectional analysis we estimate the parameter $\underset{\sim}{\pi}$, which is of interest in view of (2.32). In the pooled data analysis our aim of estimation is the parameter $\underset{\sim}{\theta}$.

2.4.1 Let the cross sectional data at a single time point be grouped into K income classes according to the value of I. Let the k-th income class has I_k for the guaranteed income. For the k-th class, three probabilities are, from (2.25), given by

$$P_{1k}=\int_{\infty}^{y_{1k}} \phi(x)\, dx$$

$$P_{2k}=\int_{y_{1k}}^{y_{0k}} \phi(x)\, dx \qquad (2.34)$$

$$P_{0k}=\int_{y_{0k}}^{\infty} \phi(x)\, dx$$

where

$$\underset{\sim}{y}_k = \begin{pmatrix} y_{0k} \\ y_{1k} \end{pmatrix} = \underset{\sim}{Z}_k \underset{\sim}{\pi}, \qquad (2.35)$$

$$\underset{\sim}{Z}_k = \begin{bmatrix} 1 & I_k & 0 & 0 \\ 0 & 0 & 1 & I_k \end{bmatrix}$$

Here, assuming that the households within the cross section are offered the common set of employment terms denoted by (w_1, h_1) and (w_2, h_2), we may say that the matrix $\underset{\sim}{X}$ is constant for every household within a particular population, and that $\underset{\sim}{\pi} = \underset{\sim}{X}\,\underset{\sim}{\theta}$ is considered to be a costant parameter. This assumption is reinforced by our data control: We apply the model to cross sectional data of approximately uniform households, since we classify the original data to obtain a sample set being in the uniform condition in terms of wives' age, wives' educational career, and the age structure of children. These attributes might be correlated with the wage rates and working hours. By controlling the sample, the wives within the cross section are expected to have almost the same age, same education, and children of the same age.

Letting $\underset{\sim}{P}_k' = [P_{0k}\ ,\ P_{1k}\ ]$, we see that $\underset{\sim}{P}_1, \ldots, \underset{\sim}{P}_K$ determine $\underset{\sim}{y}_1, \ldots, \underset{\sim}{y}_K$ uniquely, since the normal integral (2.34) is a one to one transformation when $0<P_{0k}<1$ and $0<P_{1k}<1$. And the correspondence between $\underset{\sim}{y}_1, \ldots, \underset{\sim}{y}_K$ and $\underset{\sim}{\pi}$ is written as

$$\text{(2.36)} \qquad \underset{\sim}{y}^* = \begin{pmatrix} \underset{\sim}{y}_1 \\ \vdots \\ \underset{\sim}{y}_K \end{pmatrix} = \begin{pmatrix} \underset{\sim}{Z}_1 \\ \vdots \\ \underset{\sim}{Z}_K \end{pmatrix} \underset{\sim}{\pi} = \underset{\sim}{Z}^* \underset{\sim}{\pi}.$$

Therefore if the rank of the matrix $\underset{\sim}{Z}^*$ is 4, then $\underset{\sim}{y}_1, \ldots, \underset{\sim}{y}_K$ determines $\underset{\sim}{\pi}$ uniquely. If the matrix

$$\text{(2.37)} \qquad \underset{\sim}{Z}^0 = \begin{bmatrix} 1 & \ldots & 1 \\ I_1 & \ldots & I_K \end{bmatrix}$$

is of full rank 2 then $\underset{\sim}{Z}^{*}$ is of rank 4. Thus the parameter $\underset{\sim}{\pi}$ is identifiable if the number of income classes is larger than 2 and if no collinearity is present in the matrix $\underset{\sim}{Z}^{0}$.

Although $\underset{\sim}{\pi}$ is uniquely determined, the equation (2.29) cannot determine the five dimension vector $\underset{\sim}{\theta}$ X , since the rank of $\underset{\sim}{X}$ is at most 4. We can estimate $\underset{\sim}{\pi}$ but not $\underset{\sim}{\theta}$ when a cross section at a single time point is used.

2.4.2 Estimation of $\underset{\sim}{\theta}$ is possible if cross sectional data is available for at least two time points. We use cross sectional data at time t=1 and 2. Both cross sectional data are grouped according to the guaranteed income I_{k1} for time t=1, and according to I_{k2} for time t=2. Here k_1 runs from 1 to K_1 and k_2 runs from 1 to K_2, K_1 and K_2 being number of income classes. The employment terms, w's and h's, are different at each time point and are denoted by (w_1 , h_1) and (w_2 , h_2) for full-time employment and part-time employment respectively.

From (2.25) and (2.27), the labor supply probabilities for the pooled data analysis are given by

$$
\begin{aligned}
(2.38)\qquad P_{1kt} &= \int_{\infty}^{y_{1kt}} \phi(x)\, dx, \\
P_{2kt} &= \int_{y_{1kt}}^{y_{0kt}} \phi(x)\, dx, \\
P_{0kt} &= \int_{y_{0kt}}^{\infty} \phi(x)\, dx, \qquad k=1,\dots, K_t,\ t=1,2
\end{aligned}
$$

for the household in the k-th income class at time t. Here, from (2.31), we can write

$$
(2.39)\qquad \underset{\sim}{y}_{kt} = \begin{pmatrix} y_{0kt} \\ y_{1kt} \end{pmatrix} = \underset{\sim}{Y}_{kt}\, \underset{\sim}{\theta},
$$

where $\underset{\sim}{Y}_{kt} = \underset{\sim}{Z}_{kt}\, \underset{\sim}{X}_t$,

$$
(2.40)\qquad \underset{\sim}{Z}_{kt} = \begin{bmatrix} 1 & I_{kt} & 0 & 0 \\ 0 & 0 & 1 & I_{kt} \end{bmatrix}
$$

and $\underset{\sim}{X}_t$ is obtained by suffixing t to the variables w's and h's in the matrix $\underset{\sim}{X}$. If we write out (2.39), we get

$$(2.41)\qquad \underset{\sim}{Y}^{**}= \begin{bmatrix} \underset{\sim}{y}_{11} \\ \vdots \\ \underset{\sim}{y}_{K_1 1} \\ \\ \underset{\sim}{y}_{12} \\ \vdots \\ \underset{\sim}{y}_{K_2 2} \end{bmatrix} = \begin{pmatrix} \underset{\sim}{Y}_{11} \\ \vdots \\ \underset{\sim}{Y}_{K_1 1} \\ \\ \underset{\sim}{Y}_{12} \\ \vdots \\ \underset{\sim}{Y}_{K_2 2} \end{pmatrix} \underset{\sim}{\theta} = \underset{\sim}{Y}^{**}\underset{\sim}{\theta} \ .$$

where

$$(2.42)\qquad \underset{\sim}{Y}^{**} = \underset{\sim}{Z}^{**}\underset{\sim}{X}^{*};\qquad \underset{\sim}{Z}^{**}=\begin{pmatrix} \underset{\sim}{Z}_1^{*} & 0 \\ 0 & \underset{\sim}{Z}_2^{*} \end{pmatrix}\qquad \underset{\sim}{Z}_t^{*}=\begin{pmatrix} \underset{\sim}{Z}_{1t} \\ \vdots \\ \underset{\sim}{Z}_{K_t t} \end{pmatrix}\qquad \text{and } \underset{\sim}{X}^{*}=\begin{pmatrix} \underset{\sim}{X}_1 \\ \underset{\sim}{X}_2 \end{pmatrix}$$

In a way similar to the identifiability discussion for the cross sectional analysis, we see that the identifiability of the structural parameter $\underset{\sim}{\theta}$ is dependent on the rank of $\underset{\sim}{Y}^{**}$.
If $\underset{\sim}{Z}_t^{0}$ defined analogously to (2.37) is full rank for t= 1, 2, then $\underset{\sim}{Z}_1^{*}$ and $\underset{\sim}{Z}_2^{*}$ both have rank 4. And consequently $\underset{\sim}{Z}^{**}$ has rank 8. In our designing the matrix $\underset{\sim}{X}^{*}$ its full rank is assured. Therefore $\underset{\sim}{Y}^{**}$ is of full rank unless nuisance collinearity appears after multiplying $\underset{\sim}{Z}^{**}$ and $\underset{\sim}{X}^{*}$.

2.5 The survey is conducted every three years throughout the country and a sample of some 800,000 individuals or 300,000 households is collected. One of the advantages of this data set is that because of its large size one can disaggregate the sample quite finely in order to control the effects of compounding factors. The other advantage is that the survey contains extensive questions to investigate the labor force status of respondents so that the survey provides rich information for labor supply analysis.

The basic data we used are the micro-level household data files of the Basic Survey of Employment Structure. We used the data files of the Basic Survey of Employment Structure for the years 1974 and 1977 . On the other hand, the survey gives only limited information on wage rates. We therefore supplemented this weak point by utilizing rich information on wage structure taken from the Basic Survey of Wage Structures conducted every year by the Ministry of Labor.

Samples were taken only from households whose heads are employees, and also without parent(s) of household's head and/or of spouse living together. This set of samples was then subdivided into 32 different types classified by (1) age of wives; 20-29, 30-39, 40-49, 50-59, (2) education of wives; junior or senior high school, (3) age composition of children; four groups depending upon whether the family has children in the age range of 0 to 5, and/or 6 to 14. Each of the 32 groups of households was then classified into 15 cells according to the income class of the household head. We then find for each cell the following variables; sample size, part-time employees, full-time employees, non-labor force people, and the average real income level of household head. The Basic Sruvey of Employment Structure does not have information about property income. Then let us presume the income of household head as guaranteed income I . When the sample size in a cell is less than 100, we did not estimate the parameters in these groups of households. As a result the values of the parameter of 13 groups of households, as shown in Table 3, were estimated. Every household within a household group is assumed to face common employment terms at a single time point.

We attempted estimation of parameters in two different steps, as explained before. The first step was, using cross-sectional data files for 1974 and 1977 separately, to estimate the reduced form parameter $\underset{\sim}{\pi}$. The second step was to estimate the value of the structural parameter θ's using the pooled data sets for year 1974 and 1977. Pooling data sets for two years enabled us to conduct direct estimation of θ's since the variation of values for h's and w's across different years helped to satisfy the identifiability condition of the system.

3 Statistical Methods

3. 1 Here we concider the statistical procedures for measuring the parameter $\underset{\sim}{\pi}$ by using cross sectional at a single time point, and the parameter $\underset{\sim}{\theta}$ by using two sets of cross sectional data. For the cross sectional estimation, we classify the data concerning N households into K income classes according to the values of guaranteed income I , k=1, . . . K. By N we denote the number of households in the k-th class. Suppose that, among N households, L households choose the full-time employment option, S households choose the part-time employment option and M households choose the no market work option, where N =L +S +M .

The probability that this event occurs is given by the trinomial distribution,

(3.1)

$$F_k = \frac{N_k!}{L_k!\ S_k!\ M_k!}\ P_{1k}^{\ L_k}\ P_{2k}^{\ S_k}\ P_{0k}^{\ M_k} \quad , k = 1 , \ldots, K$$

where P_{1k} , P_{2k} and P_{0k} are given by (2.34). The observed ratios

$$p_{1k}=L_k / N_k,$$

(3.2) $$p_{2k}= S_k / N_k,$$

$$p_{ok}= M_k /N_k \quad =(1-p_{1k} -p_{2k})$$

or the labor force participation ratio for each employment opportunity, are the observed couterpart of P_{1k} , P_{2k} and P_{ck} . If the probability distribution F_k applies to the k-th imcome class, we obtain, under the stochastic independence assumption, the likelihood function F for cross sectional date at a single time point,

(3.3) $$F = \prod_{k=1}^{K} F_k$$

We get the likelihood equation by a straightfoward differentiation of (3. 3) with respect to π,

(3.4)

$$\frac{\partial \ln}{\partial \underset{\sim}{\pi}} = \sum_{k=1}^{K} \frac{\partial y_k'}{\partial \underset{\sim}{\pi}} \underset{\sim}{\Phi}_k^{-1} N_k \begin{pmatrix} \frac{p_{0k}}{P_{0k}} - \frac{p_{2k}}{P_{2k}} \\ \frac{p_{1k}}{P_{1k}} - \frac{p_{2k}}{P_{2k}} \end{pmatrix} = \underset{\sim}{0},$$

where

(3.5)

$$\underset{\sim}{\Phi}_k^{-1} = \begin{pmatrix} \phi(y_{0k}) & 0 \\ 0 & \phi(y_{1k}) \end{pmatrix}$$

$$\frac{\partial \underset{\sim}{y}_k}{\partial \underset{\sim}{\pi}} = \underset{\sim}{z}_k'$$

If we let

(3.6)

$$\underset{\sim}{\Gamma}_k = \frac{1}{N_k} \begin{pmatrix} P_{0k}(1-P_{0k}) & -P_{1k}P_{0k} \\ -P_{0k}P_{1k} & P_{1k}(1-P_{1k}) \end{pmatrix}$$

(3.7)

$$\underset{\sim}{\wp}_k = \underset{\sim}{\Phi}_k^{-1} \begin{pmatrix} p_{0k} & -P_{0k} \\ p_{1k} & -P_{1k} \end{pmatrix}, \qquad \underset{\sim}{\Omega}_k^{-1} = \underset{\sim}{\Phi}_k^{-1} \underset{\sim}{\Gamma}_k^{-1} \underset{\sim}{\Phi}_k^{-1}$$

then $\underset{\sim}{\Gamma}_k$ is a covariance matrix of $p_k' = (p_{0k}, p_{1k})$ and $\underset{\sim}{\Omega}_k^{-1}$ is an approximate covariance matrix of $\underset{\sim}{y}_k$, we can write the likelihood equation in the form,

(3.8)

$$\frac{\partial \ln F}{\partial \underset{\sim}{\pi}} = \sum_{k=1}^{K} \underset{\sim}{Z}_k \underset{\sim}{\Omega}_k^{-1} \underset{\sim}{\wp}_k = \underset{\sim}{0}$$

To get the Maximum Likelihood Estimate of π, we solve this equation using the scoring method. The scoring method is an interative procedure presented as

$$(3.9)\qquad \underset{\sim}{\pi}^{(i+1)} = \underset{\sim}{\pi}^{(i)} + \underset{\sim}{I}(\underset{\sim}{\pi}^{(i)})^{-1} \left.\frac{\partial \ln F}{\partial \pi}\right|_{\underset{\sim}{\pi}^{(i)}} \quad i=1,2,\ldots.$$

where $\underset{\sim}{I}(\underset{\sim}{\pi})$ is the information matrix given as

$$(3.10)\qquad \underset{\sim}{I}(\underset{\sim}{\pi}) = -E\left\{\frac{\partial^2 \ln F}{\partial \underset{\sim}{\pi}\, \partial \underset{\sim}{\pi}'}\right\} = -\sum_{k=1}^{K} Z_k' \Omega_k^{-1} Z_k,$$

and $\underset{\sim}{\pi}^{(i+1)}$ is the (i+1)-st approximation to the MLE. To obtain the initial value π, we linearize the likelihood equation. First we define $\{\eta_{0k}, \eta_{1k}\} \equiv \underset{\sim}{\eta}_{1k}$ by

$$(3.11)\qquad \int_{-\infty}^{\eta_{1k}} \phi(X)\, dx = p_{0k},$$

$$\int_{0k}^{\infty} \phi(X)\, dx = p_{1k}.$$

The $\underset{\sim}{\eta}_k$ is approximation to $\underset{\sim}{y}_k$. Then by Taylor expansion we obtain

$$(3.12)\qquad \underset{\sim}{p}_k \doteq \underset{\sim}{p}_k + \Phi(\underset{\sim}{y}_k)(\eta_k - y_k).$$

Therefore

$$(3.13)\qquad \underset{\sim}{\rho}_k = \underset{\sim}{\eta}_k - \underset{\sim}{y}_k = \underset{\sim}{\eta}_k - \underset{\sim}{Z}_k \underset{\sim}{\pi}.$$

The linearized likelihood equation is, by substituting (3.13) into (3.8),

$$(3.14)\qquad \underset{\sim}{0} = \sum_{k=1}^{K} \underset{\sim}{Z}_k \underset{\sim}{\Omega}_k^{-1} \underset{\sim}{\rho}_k = \Sigma\, \underset{\sim}{Z}_k \underset{\sim}{\Omega}_k^{-1} \underset{\sim}{\eta}_k - \Sigma\, \underset{\sim}{Z}_k \underset{\sim}{\Omega}_k^{-1} \underset{\sim}{Z}_k \underset{\sim}{\pi}.$$

We use this linear equation in π to obtain the initial value π,

$$(3.15) \qquad \pi^{(1)} = \left\{\Sigma\ Z_k \Omega_k^{-1} Z_k\right\}^{-1} \left\{\Sigma\ Z_k\ \Omega_k^{-1} \eta_k\right\}$$

For actual calculation of (3.15) we substitute the directly observed p_k and η_k derived by (3.11) in the place of P_k and y_k, see (3 4) and (3.6). That is, p_k and η are the "o-th" approximation to $P_k^{(i)}$ and y_k.

Once $\pi^{(i)}$ is calculated for $i \geq 1$, we calculate $y_k^{(i)}$ and $P_k^{(i)}$, using

$$(3.16) \qquad y_k^{(i)} = Z_k \pi^{(i)},$$

$$P_{ok}^{(i)} = \int_{-\infty}^{y_{1k}^{(i)}} \phi(x)\ dx, \qquad P_{1k}^{(i)} = \int_{y_{ok}^{(i)}}^{\infty} \phi(x)\ dx,$$

to be substituted for y_k and P_k, which are necessary for the (i+1)-st iteration.

A change of the teration process is defined as

$$(3.17) \qquad d^{(i+1)} = \left| \pi^{(i+1)} - \pi^{(i)} \ / \ \pi^{(i)} \right|$$

for each element of $\pi^{(i+1)}$ When the change $d^{(i+1)}$ becomes less than 1/100 for every element of π, we stop the iteration process and consider the last value as the MLE of π.

We use the classical results concerning the asymptotic property of the MLE, since the regularity condition applied to the non-classical framework of the present model is yet uncertain. Therefore we consider that the MLE is asymptotically normal with mean π and covariance matrix equal to the inverse of the information matrix $I(\pi)$. And our significance test is conducted based on the normal distribution. For the goodness of fit test, we use Person's χ^2 statistic.

$$(3.18)\quad \chi^2 = \sum_{k=1}\left(\left(\frac{M_k - N_k P_{0k}}{N_k P_{0k}}\right)^2 + \left(\frac{L_k - N_k P_{1k}}{N_k P_{1k}}\right)^2 + \left(\frac{S_k - N_k P_{2k}}{N_K P_{2k}}\right)^2\right.$$

$$= \Sigma_k\, \underset{\sim}{e}'_k\, \Sigma_k^{-1} \underset{\sim}{e}_k,$$

where $\underset{\sim}{P}_k$ is the prediction evaluated by using the MLE, see (3. 16). The χ^2, in the classical framework, is known to be distributed as the χ^2 with degrees of freedomn equal to the number of independent cells minus the number of the estimated parameters, i. e. , n=(3-1)K-4 .

3.2 We estimate the parameter $\underset{\sim}{\theta}$ using cross sections at two time points t=1, 2, without introducing any complicated stochastic structure for combining the cross sections. The cross sectional data at time t has K_t income classes, the guaranteed income of the k-th class being I_{kt} and the number of households in the k-th class being N_{kt} for each t. Let L_{kt}, S_{kt} and M_{kt} be respectively the number of households choosing full-time, part-time, and no-market work option, where $N_{kt} = L_{kt} + S_{kt} + M_{kt}$. The likelihood funtion for the single cross sectional data is

$$(3.19)\quad F^*_{(t)} = \prod_{k=1}^{K_t} \frac{N_{kt}!}{L_{kt}!\, S_{kt}!\, M_{kt}!} \cdot P_{1kt}^{L_{kt}}\; P_{2kt}^{S_{kt}}\; P_{0kt}^{M_{kt}} \quad , t=1,2$$

where P_{1kt}, P_{2kt} and P_{0kt} are given by (2. 38). The likelihood function for the pooled date is a simple product,

$$(3.20)\quad F^* = F^*_{(1)} \cdot F^*_{(2)}\ ,$$

under the condition that the data sampling for both cross sections is conducted independently. The likelihood equation is derived by a straightforward differentiation of F^* with respect to $\underset{\sim}{\theta}$,

$$(3.21)\quad \frac{\partial \ln F^*}{\partial \theta} = \frac{\partial \ln F^*(1)}{\partial \underset{\sim}{\theta}} + \frac{\partial \ln F^*(2)}{\partial \underset{\sim}{\theta}}$$

$$= \sum_{t=1}^{2} \sum_{k=1}^{kt} \frac{\partial \underset{\sim}{y}'_{kt}}{\partial \underset{\sim}{\theta}} \underset{\sim}{\Phi}_{kt}^{-1} N_{kt} \begin{pmatrix} \frac{p_{0kt}}{P_{0kt}} - \frac{p_{2kt}}{P_{2kt}} \\ \frac{p_{1kt}}{P_{1kt}} - \frac{p_{2kt}}{P_{2kt}} \end{pmatrix} = \underset{\sim}{0}.$$

Here

$$\begin{aligned} &p_{1kt}=L_{kt}/N_{kt}, \\ (3.22)\quad &p_{2kt}=S_{kt}/N_{kt}, \\ &p_{0kt}=M_{kt}/N_{kt} \end{aligned}$$

are direct estimates of P_{1kt}, P_{2kt} and P_{0kt}, and

$$\underset{\sim}{\Phi}_{kt} = \begin{pmatrix} \phi(y_{0kt}) & 0 \\ 0 & \phi(y_{1kt}) \end{pmatrix},$$

(3.23)

$$\frac{\partial \underset{\sim}{y}'_{kt}}{\partial \underset{\sim}{\theta}} = \underset{\sim}{Y}'_{kt}.$$

If we let

$$\underset{\sim}{\Gamma}_{kt} = \frac{1}{N_{kt}} \begin{pmatrix} P_{0kt}(1-P_{0kt}) & -P_{0kt}P_{1kt} \\ -P_{1kt}P_{0kt} & P_{1kt}(1-P_{1kt}) \end{pmatrix}$$

(3.24)

$$\underset{\sim}{\ell}_{kt} = \underset{\sim}{\Phi}_{kt}^{-1} \begin{pmatrix} p_{0kt} - P_{0kt} \\ p_{1kt} - P_{1kt} \end{pmatrix}$$

$$\underset{\sim}{\Omega}_{kt}^{-1} = \underset{\sim}{\Phi}_{kt}^{-1} \underset{\sim}{\Sigma}_{kt}^{-1} \underset{\sim}{\Phi}_{kt}^{-1},$$

we can rewrite the likelihood equation in the form

(3.25) $$\underset{\sim}{0} = \sum_{t=1}^{2} \sum_{k=1}^{K_t} \underset{\sim}{Y}_{kt}' \underset{\sim}{\Omega}_{kt}^{-1} \underset{\sim}{\ell}_{kt}$$

The scoring method to solve (3. 25), using the information matrix

(3.26) $$\underset{\sim}{I}(\underset{\sim}{\theta}) = \sum_{t=1}^{2} \sum_{k=1}^{K_t} \underset{\sim}{Y}_{kt}' \underset{\sim}{\Omega}_{kt}^{-1} \underset{\sim}{Y}_{kt},$$

is given by

(3.27) $$\underset{\sim}{\theta}^{(i+1)} = \underset{\sim}{\theta}^{(i)} + \underset{\sim}{I}(\underset{\sim}{\theta}^{(i)})^{-1} \left. \frac{\partial \ln F}{\partial \underset{\sim}{\theta}} \right|_{\underset{\sim}{\theta}^{(i)}}$$

The initial value θ is derived similarly to (3. 13) and (3. 14), as

(3.28) $$\underset{\sim}{\theta}^{(1)} = \left(\sum_t \sum_k \underset{\sim}{Y}_{kt}' \underset{\sim}{\Omega}_{kt}^{-1} \underset{\sim}{Y}_{kt} \right)^{-1} \left(\sum_t \sum_k \underset{\sim}{Y}_{kt} \underset{\sim}{\Omega}_{kt}^{-1} \underset{\sim}{\eta}_{kt} \right),$$

where $\underset{\sim}{\eta}_{kt}' = [\ \eta_{okt} \quad \eta_{1kt}\ ]$ are defined by

$$\int_{-\infty}^{\eta_{1kt}} \phi(x)\, dx = P_{0kt},$$

(3.29) $$\int_{\eta_{0kt}}^{\infty} \phi(x)\, dx = p_{1kt},$$

For the calculation of(3. 28), we need the value of $\underset{\sim}{\Omega}_{kt}$ or its elements, P_{okt} , P_{1kt} , and y_{okt}, y_{1kt} . Their "0-th" approximation p_{okt} , p_{1kt} and η_{okt}, η_{1kt} are substituted.

Once $\underset{\sim}{\theta}^{(i)}$, $i \geq 1$ is obtained, we calculate $\underset{\sim}{y}_{kt}^{(i)}$ and $P_{0kt}^{(i)}$, $P_{1kt}^{(i)}$ using

$$(3.30) \qquad y_{kt}^{(i)} = \underset{\sim}{Y}_{kt}\ \underset{\sim}{\theta}^{(i)}$$

$$P_{0kt}^{(i)} = \int_{-\infty}^{y_{1kt}(i)} \phi(x)dx, \qquad P_{1kt}^{(i)} = \int_{y_{0kt}}^{\infty}(i)\ \phi(x)dx,$$

to be used in the (i+1)-st iteration. When the change of iteration, defined similarly to (3. 17), becomes less than 1/100, we stop the iteration process.

We apply the classical analysis on the property of the MLE to our significance test. In certain regularity conditions, the MLE is asymptotically distributed as normal with the mean $\underset{\sim}{\theta}$ and the covariance matrix equal to the inverse of the information matrix, $\underset{\sim}{I}(\underset{\sim}{\theta})^{-1}$. The regularity condition for our non-classical case is yet uncertain.

The goodness of fit test is performed using Pearson's χ^2, where $\chi^2 = \chi_1^2 + \chi_2^2$,

$$(3.31) \qquad \chi^2 = \sum_{t=1}^{2}\sum_{k=1}^{K_t}\left\{\left(\frac{M_{kt} - N_{kt}P_{0kt}}{N_{kt}P_{0kt}}\right)^2 + \left(\frac{L_k - N_kP_{1kt}}{N_{kt}P_{1k}}\right)^2 + \left(\frac{S_k - N_kP_{2k}}{N_{kt}P_{2k}}\right)^2\right\}$$

being defined similarly as (3.18) in our case.In the classical case χ^2 is asymptotically distributed as χ^2 with degrees of freedom n=the number of independent cells minus the numberof estimated parmeters, i.e. $n=(3-1)(K_1+K_2)-5$.

From the viewpoint that the statistical inference relies on the classical results for the asymptotic property of the MLE and the χ^2-statistic, it should be mentioned that the conclusion is not decisive.

4. Estimated Results

4. 1 Cross Sectional Analysis

The results of estimation by using cross sectional data sets for years 1974 and 1977 separately are shown in Tables 3 and 4. Two of criteria are used for testing the estimated results: statistical criteria and criteria referring to the sign of parameters.

Let us begin with statistical tests. The two test statistics, χ^2 and the significance-test statistic, both explained in section 3, are shown in Tables 3 and 4. Figures in the last row indicate the magnitudes of χ^2 and those in parentheses the magnitudes of the significance-test statistic. Asterisks attached to figures denote statistical level of significance in hypothesis testing. ** and * respectively correspond to 0.5% and 5% levels.

According to the results for 1974 (Table3), our model cannot be rejected in the goodness of fit test (χ^2 test)at the 5% significant level in 11 household types of 13. We have the same estimated results for 1977 (Table4). Furthermore, the results of the significance test show that 48 parameters of 52 in 1974 and 45 parameters of 52 in 1977 are significant at the 0.5% level. Consequently , we conclude that our model satisfies the statistical criterion in the case of estimation by using cross sectional data sets separately. Next we will consider the criteria referring to the estimated parameters. Empirical studies on the supply of labor began in the 1930s with the pioneering work of Paul Douglas(1934). Since then, many researchers have carried out empirical analyses of labor supply. Their empirical findings make it clear that (1) the participation rate of married women behaves as a decreasing function of husband's income, and (2) it behaves as an increasing function of own wage rate offered by the firm. Because these findings are very stable and can be widely across many countries, we adopt this well documented evidence as the empirical criterion to which the estimated result should conform. In the case of estimation by using cross sectional data; since we cannot estimate the structural parameter, it is impossible to test whether our estimated reduced parameter, implies that own wage rate exert a positive influence on the female participation ratio.

The first empirical criterion, the negative effect of husband's income on the female participation ratio, depends on the sign of estimated parameters π_{01} and π_{11} in our model, as derived from equations (2. 32) and (2. 33). If they have negative signs, our model coforms to the criteria. Tables 3 and 4 indicate that π_{01} and π_{11} are negative and significant at the 5% statistical level in every household type except E type for 1977. It can be ascertained that our model satisfies the empirical criterion on the estimation by using the cross sectional data at a single time point, too.

4.2 Analysis of Pooled Data Sets

Pooling the data sets for more than two years enables us to estimate directly the structural parameters, θ . The estimated results by these date, as shown in Table 5, are quite poor. Of 13 types of householdes for which we are able to conduct estimation, our model passes the goodness of fit test in only 2 types, D and G. In the remaining 11 types, the model does not have sufficient explanatory power.

Furthermore, a simulation by using the estimated parameter from pooled data sets indicates that our model does not conform to the empirical criterion in 11 types of households except types A and B, and that the increase of own wage rate makes the predicted values of participation ratio decline.

From the view points of both statistical and empirical criteria, we have judged it necessary to modify our model in order to explain the pooled data sets. What causes the model to lose the explantory power for the pooled data sets? And what kinds of variables should be introduced to the model?

To find new variables to be introduced into modified model, Figure 6 (A) exhibits the household head's income on the horizontal axis and the observed values and theoretical values of full-time paticipation ratio on the vertical axis. The theoretical values are predicted by the estimated parameters in Table 5 and the actual values of the exogenous variables.

The line which shows the observed relationship between the participation ratio and household head's income shifts upward from 1974 to 1977 substantially. Namely, the female participation ratio rises rapidly even holding household head's income constant. In the model, we tried to explain this situation by the increase of her own wage rates and changes of assigned working hours. Depending on estimated parameters, however, these variables can explain only a small part of the increase in female participation. As a result, we have overestimated values in 1974 and underestimated values in 1977. More interesting is that the gap between observed values and theoretical values is different among the household head's income classes. It is relatively wider in the higher income classes in 1974 and in the lower income in 1977. These situations are common to most types of household.

Taking into consideration these facts, we have to select a new variable to be introduced into the model that satisfies the following two criterion: (i) It causes the participation ratio of wives to rise in 1977, (ii) It makes the slopes of the curve which indicates the relationship between participation ratio and head's income steeper in 1974 and gentler in 1977.

4.3 Modifying the Model by Introducing an Element of Habit Formation

In the previous sections, since we have not included any variables other than household income and leisure hours in the utility indicator, it has been assumed that the shapes of the indifference curve in the income-leisure preference field, or exactly speaking their distribution among households in the same type, are fixed and constant in 1974 and 1977. Observing the estimated results by using pooled data sets, however, we cannot help but doubting this assumption. It seems necessary for us to introduce same variables into the model which will vary the shape of the indifferece curve systematically.Taking account of the previous two criteria, we will try to find the systematic factors other than age of wife, her educational career and age composition of children, which were already controlled in our model.

Now, let us refer to the study of consumption. Many studies of consumption have pointed out that the element of habit formation is one of the key variables that yields consistent explanation for long-run time series consumption data and cross-sectional data. The relationship between household income and consumption is usually observed to be different in long-run time series data and cross--section data. Many researchers have tried to give a consistent explanation for both of them. J. S. Duesenberry(1948) succeeded in explaining both of them by introducing the habit formation effect intothe preference indicator. It was proved that household preferences were influenced by their consumption history, and propensity to consume was determined by the highest income level of the household in the past. Since then, H. S. Houthakker and L. D. Taylor(1966), K. Tsujimura(1968) and many other researchers have confirmed that the habit formation hypothesis is useful to fill the gap between time-series analysis and cross-sectional analysis.

In this paper, the habit formation hypotheses is applied to labor supply analysis and tested empirically. The pattern of consumption formed on the basis of a certain level of income cannot be changed even though income level changes in the short-run and the gap between expenditure and income is made up by additional income earned by marginal workers in the household who are primarily housewives. This effect can be quite large if we include as an element of consumption expenditure payments for long-term housing loans. When families experience a certain period of rapid income growth, they naturally build a long-run expectation for income growth, and this effects not only their pattern of daily consumption but also long-term investments such as housing. Thus, the definition of "necessary" expenditures is directly related to the stage and pace of economic development. In early stages of economic development, the definition of "necessities" may include only food, housing, clothing, etc. As economic development proceeds the definition expands to include a greater variety of consumption goods. Once these expectations and consumption patterns are built, they cannot change easily in response to short-run changes in income. Thus they tend to affect decisions of household labor supply and consequently are reflected most sharply in female labor supply.

Taking into account these points, we should remove the previous assumption that the form of the indifference curve is permanent, and instead of it, say that the indifference curve is able to be transformed by introducing a habit formation term.

To begin, we shall define the habit formation variable, H, along the lines of Tsujimura's consumption study(1968) by

(4. 1)

$$H_{kt}=\sum_{s=1973}^{t-1} X_{ks},$$

where X_{ks} is the real household income of the k-th income class in s year. The equation implies that the habit formation term is represented by the accumulated real household income counted from year 1973 up to the year prior to the year of observation, or (t-1)-st year.

The form of the utility indicator is modified from equation (2.1) to the following equation,

(4.2) $$\omega(X,\Lambda)=\frac{1}{2}\gamma_1 X^2+(\alpha+\beta H)X+\gamma_3 X\Lambda+\overline{\gamma}_4\Lambda+\frac{1}{2}\gamma_5\Lambda^2.$$

Equation (4.2) is different in the term of the first degree of income from (2.1).

Under this specif ation, (2. 35)and(2. 36)must be rewritten by

(4.4) $$\underset{\sim}{y}_{kt}=\begin{pmatrix} y_{0kt} \\ y_{1kt}\end{pmatrix}=\begin{pmatrix} 1 & I_{kt} & H_{kt} & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & I_{kt} & H_{kt}\end{pmatrix}\begin{pmatrix}\pi_{00t} & \pi_{01t} & \pi_{02t} & \pi_{10t} & \pi_{11t} & \pi_{12t}\end{pmatrix}'$$

$$=\underset{\sim}{Z}_{kt}\underset{\sim}{\pi}_t=\underset{\sim}{Z}_{kt}\underset{\sim}{X}_t\underset{\sim}{\theta}^*,$$

where

$$\underset{\sim}{Z}_{kt}=\begin{bmatrix} 1 & I_{kt} & H_{kt} & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & I_{kt} & H_{kt}\end{bmatrix},$$

(4.5) $$\underset{\sim}{\pi}_t'=[\pi_{00t}\ \pi_{01t}\ \pi_{02t}\ \pi_{10t}\ \pi_{11t}\ \pi_{12t}],$$

$$\underset{\sim}{\theta}^{*\prime}=[\gamma_1/6\quad \alpha/6\quad \beta/6\quad \gamma_3/6\quad \gamma_4/6\quad \gamma_5/6],$$

$$
\underset{\sim}{X} = \begin{pmatrix}
h_{2t}w_{2t}^{2}/2 & w_{2t} & 0 & w_{2t}(T-h_{2t}) & -1 & \frac{h}{2}-T \\
w_{2} & 0 & 0 & -1 & 0 & 0 \\
0 & 0 & w_{2t} & 0 & 0 & 0 \\
\frac{h_{1t}^{2}w_{1t}^{2}-h_{2t}^{2}w_{2t}^{2}}{2(h_{1t}-h_{2t})} & \frac{h_{1t}w_{1t}-h_{2t}w_{2t}}{h_{1t}-h_{2t}} & 0 & \frac{h_{1t}w_{1t}(T-h_{1t})-h_{2t}w_{2t}(T-h_{2t})}{h_{1t}-h_{2t}} & -1 & \frac{h_{1t}+h_{2t}}{2}-T \\
\frac{h_{1t}w_{1t}-h_{2t}w_{2t}}{h_{1t}-h_{2t}} & 0 & 0 & -1 & 0 & 0 \\
0 & 0 & \frac{h_{1t}w_{1t}-h_{2t}w_{2t}}{h_{1t}-h_{2t}} & & 0 & 0
\end{pmatrix}
$$

The marginal utility function of income is proved to be (4.6) under the utility indicator formulation (4. 2)

(4. 6) $\quad \partial\omega/\partial X = \alpha + \beta H + \gamma_3 \Lambda + \gamma_1 X$

The estimated parameter β is expected to have a positive sign, because the habit formation effect must raise the marginal utility of income If this condition is satisfied, parameters, π_{02t} and π_{12t} , have positive signs, too. Comparing the values of H for the same income class k in 1974 and 1977, it is clear that in 1977 it is larger than in 1974, from equation (4. 1). Consequently, y_{0kt} and y_{1kt} must rise in 1977 ceteris paribus, and this implies that the full-time participation ratio and total participation ratio become higher in 1977 than in 1974. It satisfies the first criterion in selecting a new variable was mentioned above. Next, we consider whether introduction of a habit formation term into the preference indicator satisfies th cond criterion for modifying the model, which was mentioned in thelast section. The degree of habit formation depends on the past income of the husehold. If it is assumed that most people with relatively high income last year also have high current income, the magnitude of habit formation is, in general, large in high income househoulds. Since habit formation influences the full-time participation ratio and total participation ratio positively through y_{0kt} and y_{1kt}, by our modification of the model, they will increase more rapidly in higher household head's income classes. Then the introduction of habit formation is in accordance with the secod criterion.

Table 6 indicates the estimated results of the modified model by using the maximum likelihood estmation method. Comparing these results with those of the previous model, Table 5, it is clear that the modified model has been surprisingly improved. In the case of the χ^2 test, the previous model was not rejected in only two types of household groups at the 0.5% significance level, but the modified model was not rejected in eight types. Furthermore, in significance tests of parameters, the number of parameters which are not significant at the 0.5% level decreases from 17 to 9. In order to compare the fit of the models with the habit formation term and without it, let us plot the observed full-time participation ratio and predicted ratio by the modified model of households type C in Figure 6(B), as we did in Figure 6(A). The phenomenon of overestimates in 1974 and under-estimates in 1977 in Figure 6(A) disappears in Figure 6(B), and the slope is improved to be steeper in 1974 and gentler in 1977.

It is still more interesting to consider the results from the viewpoint of the empirical criterion. In the previous model, as mentioned above the simulation indicated that an increres in own wage rate caused the predicted participation ratio to decline. These simulat results are contrary to the well documented evidence which many previous studies have found. On the other hand , the simulation inditates that in the modified model own wage rate has a positive effects on the partipation ratios in 10 types of household groups except the young family types A and B. The modification by introducing the habit formation effect is judged useful from this criterion.

What is implied by the fact that the habit formation effect, as being specified in equation (4. 1), is significant? The estimated parameter β has a positive sign in every type of household group, as expected before estimation. Households with high income in the past have already formated the habits for consumption and saving, and their marginal utility for current income has increased. As a result, under other given condition, the participation ratio of wives in these households is high. Supposing we apply this fact to time series data, even if the household head's income and wife's wage rate are constant the participation ratio of married females rises under the condition where the growth rate of income is low, because the magnitude of their habit formation is large. Let us consider two countries where the current income is the same but the growth rate of income is different. In the country whose growth rate of income is low, since people's past income must have been high, the magnitude of habit formation is large. On the contrary, people in the country whose income growth rate is high have a small magnitude of habit formation. Consequently, ceteris paribus the participation ratio of married females is high under the condition where the growth rate of income is low.

5 Implicatios and Concluding Remarks

Figures 8 and 9 show the magnitudes of the influences on the full-time and part-time labor force particifation ratio of married females by household head's income, own wage rates and assigned working hours assessed on the basis of pooled data estimation. The basic case is supposed as follows; household head's income=2 million yen/year, wage rate in full-time job =730 yen/hour, assigned working hours in full-time job=2200 hours/year, wage rate in part-time job=460 yen/hour, assigned working hours in part-time job=1500 hours/year, and habit formation=2 million and 3 hundred thousand yen. The point at the bottom of Figures 7 and 8 indicates the predicted value of full-time participation in each type of household group under the given exogenous variables. The net influences of household head's income, each hourly wage rates and assigned working hours are shown by the points in the upper part of the Figure.

To begin with in observing the habit formation effects, it increases the full-time participation ratio and reduce the part-time participation ratio in the opposite direction. These effects are especially strong in the household whose wife is in the age bracket 30 to 39, with senior high school education and without children. The negative effect of household head's income on wife's labor supply works as a factor to reduce full-time participation of wives. The households where wife is in the age range of 40 to 49, with senior high school education and without children, exhibit strong effects of household head's income. This effect for the part-time participation ratio is negligible. Now let us turn to the effect of wage rates and assigned working hours on each job opportunity. The increase in the wage rate and shortening of assigned working hours raises the assigned working hours on each job opportunity. The increase in the wage rate and shortening of assigned working hours raises the corresponding participation ratio. More interesting is that the elasticity of assigned working hours is as great as that of the wage rate for female workers in Japan.

Finally along the lines of our estimated results, let us consider the reason why female labor force participation took off making the first oil crisis as turning point. The results of our analysis suggests that the change in the labor supply of married women observed between 1974 and 1977 can be successfully explained by the effect of habit formation. In other words, even for the same level of household head's income, wives of families whose past income levels were higher tend to participate in the labor market more than otherwise.

In this way, movements of the Japnese female labor force participation ratio over time are reasonably well explained by our modified model of choice between part-time and full-time employment opportunities that includes the habit formation effect.

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Table 1 Female Labor Force Participation Ratio in Japan

	Aggregate Participation Ratio(All Women)	Aggregate Participation Ratio(In Employee Household)
1960	54.5%	----
65	50.6	----
70	49.9	39.5
73	48.2	39.1
74	46.5	37.9
75	45.7	37.2
76	45.8	38.0
77	46.6	39.2
78	47.4	40.3
79	47.6	41.0
80	47.6	41.9
81	47.7	42.4
82	48.0	43.2

An employee household is defined as a houshold whose head is an employee.
Source:Prime Minister's Office, Bureau of Statisics, Labor Force Survey.

Table 2 Percentage of Women in Given Categories in the Labor Force

	Percentage of all women who are employed	Percentage of all women who are unpaid family workers	Percentage of all women who are employees	Percentage of female non-agriculturalemployees who are part-time wokers
1960	8.5	23.3	21.9	8.9
65	7.3	18.4	24.3	9.6
70	7.0	15.2	27.0	12.2
73	7.3	12.3	27.9	14.7
74	6.9	11.7	27.3	16.1
75	6.4	11.5	26.9	17.4
76	6.3	11.2	27.4	16.4
77	6.3	11.2	28.2	16.6
78	6.4	11.4	28.5	17.2
79	6.5	11.2	28.9	18.4
80	6.4	10.7	29.5	19.3
81	6.2	10.4	30.0	19.6
82	6.3	10.3	30.3	20.5

Part-time emploees are defined as those employees who work less than 35 hours during a normal week.
Source: Prime Minister's Office, Bureau of Statistics, Labor Force Survey.

Table 3-1 The Estimated Results Using Cross Sectional Data(1974)

Type of households	A	B	C	D	E	F	G
Age of wife	20-29	20-29	30-39	30-39	30-39	30-39	30-39
Educational level	Senior high	Senior high	Junior high	Junior high	Senior high	Senior high	Senior high
No.of children age 0 to 5	0	1+	0	1+	0	0	1+
No.of children age 6 to 14	0	0	1+	1+	0	1 +	1+
π_{00}	0.143017 (2.0905)**	−0.387773 (4.4986)**	−0.213105 (5.0395)**	−0.848854 (6.9376)**	−0.373924 (4.3335)**	−0.223612 (5.0233)**	−0.646859 (6.5641)**
π_{01}	−0.443018*E*-2 (13.0115)**	−0.444613*E*-2 (10.3198)**	−0.187976*E*-2 (9.4539)**	−0.136785*E*-2 (2.1894)**	−0.158662*E*-2 (4.5080)**	−0.223469*E*-2 (13.6767)**	−0.205044*E*-2 (5.5246)**
π_{10}	0.140904 (2.0080)**	−0.403453 (4.4552)**	−0.293823 (6.5895)**	−0.845024 (6.4208)**	−0.469477 (5.2335)**	−0.342035 (7.0876)**	−0.859585 (7.8406)**
π_{11}	−0.481188*E*-2 (13.6870)**	−0.490439*E*-2 (10.6929)**	−0.260022*E*-2 (12.1663)**	−0.252435*E*-2 (3.6753)**	−0.174892*E*-2 (4.7486)**	−0.269280*E*-2 (14.8271)**	−0.203651*E*-2 (4.8801)**
Number of iterations	2	6	2	2	2	2	3
χ^2	12.3679*	25.4683*	12.0158*	14.5842*	16.0688*	53.3770	17.5986*
Degrees of freedom	(14)	(18)	(22)	(18)	(20)	(24)	(20)

* Significant at 5% level

** Significant at 0.5% level

Table 3-2 The Estimated Results Using Cross Sectional Data(1974)

Type of households	H	I	J	K	L	M
Age of wife	40-49	40-49	40-49	40-49	50-59	50-59
Educational level	Junior high	Junior high	Senior high	Senior high	Junior high	Senior high
No of children age 0 to 5	0	0	0	0	0	0
No of children age 6 to 14	0	1+	0	1+	0	0
π_{00}	0.134716 (3.6021)**	0.688481 E-1 (1.4742)	0.188901 (3.7711)**	0.145046 (2.3149)**	-0.239155 (6.5805)**	-0.419739 (7.5497)**
π_{01}	-0.192212 E-2 (11.6629)**	-0.216030 E-2 (10.0051)**	-0.244606 E-2 (14.9229)**	-0.266427 E-2 (12.7741)**	-0.180946 E-2 (9.5588)**	-0.143641 E-2 (7.1084)**
π_{10}	0.417320 E-1 (1.1025)	-0.654399 E-3 (0.0137)	0.143411 (2.7966)**	0.762571 E-2 (0.1162)	-0.330181 (8.8667)**	-0.525639 (9.1537)**
π_{11}	-0.207537 E-2 (12.3487)**	-0.265005 E-2 (11.8329)**	-0.282109 E-2 (16.5356)**	-0.284506 E-2 (12.8149)**	-0.193761 E-2 (9.9013)**	-0.146406 E-2 (6.9616)**
Number of iterations	2	3	3	2	1	2
χ^2	27.0009*	17.2905*	59.7249	30.7682*	21.1609*	43.5963**
Degrees of freedom	(22)	(22)	(24)	(20)	(22)	(24)

Table 4-1 The Estimated Results Using Cross Sectional Data(1977)

Type of households	A	B	C	D	E	F	G
Age of wife	20-29	20-29	30-39	30-39	30-39	30-39	30-30
Educational level	Senior high	Senior high	Junior high	Junior high	Senior high	Senior high	Senior high
No of children age 0 to 5	0	1+	0	1+	0	0	1+
No of children age 6 to 14	0	0	1+	1+	0	1+	1+
π_{00}	0.372695	−0.465163	−0.119742	−0.499873	−0.152782	−0.798692E−1	−0.311284
	(5.0006)**	(7.8427)**	(2.6241)**	(5.7210)**	(0.9779)	(1.8054)	(4.2649)**
π_{01}	−0.315081E−2	−0.340972E−2	−0.148061E−2	−0.238823E−2	−0.977042E−3	−0.185405E−2	−0.258908E−2
	(8.9229)**	(12.6646)**	(7.7744)**	(6.1197)**	(1.5147)	(13.3968)**	(10.0106)**
π_{10}	0.320492	−0.531305	−0.187013	−0.560942	−0.163963	−0.184627	−0.499955
	(4.2628)**	(8.5832)**	(3.9619)**	(5.9153)**	(1.0310)	(3.8891)**	(6.3149)**
π_{11}	−0.325186E−2	−0.354419E−2	−0.198630E−2	−0.308657E−2	−0.153404E−2	−0.226710E−2	−0.262536E−2
	(9.0988)**	(12.5285)**	(9.9574)**	(7.1277)**	(2.3265)**	(14.9141)**	(9.2600)**
Number of iterations	2	2	2	2	2	3	2
χ^2	40.9880	25.2512*	26.5170*	10.9848*	8.3099*	69.2273	21.7232*
Degrees of freedom	(18)	(20)	(22)	(18)	(14)	(22)	(18)

Table 4-2 The Estimated Results Using Cross Sectional Data(1977)

Type of households	H	I	J	K	L	M
Age of wife	40-49	40-49	40-49	40-49	50-59	50-59
Educational level	Junior high	Junior high	Senior high	Senior high	Junior high	Senior high
No of children age 0 to 5	0	0	0	0	0	0
No of children age 6 to 14	0	1+	0	1+	0	0
π_{00}	0.286416 (7.6838)**	0.376253E-1 (0.8794)	0.377122 (7.7171)**	0.302646 (5.6156)**	−0.222342 (6.9079)**	−0.268992 (5.5833)**
π_{01}	−0.193541E-2 (14.1365)	−0.154827E-2 (9.1058)**	−0.234779E-2 (17.2271)**	−0.240145E-2 (15.3749)**	−0.136250E-2 (9.7800)**	−0.131518E-2 (9.5810)**
π_{10}	0.238371 (6.3376)**	−0.435312E-1 (0.9969)	0.276605 (5.5617)**	0.154264 (2.7576)**	−0.276292 (8.4306)**	−0.375701 (7.5810)**
π_{11}	−0.214219E-2 (15.3838)**	−0.185757E-2 (10.5963)**	−0.246607E-2 (17.5855)**	−0.259094E-2 (15.7185)**	−0.155161E-2 (10.8352)**	−0.132946E-2 (9.3422)**
Number of iterations	2	2	2	2	2	2
χ^2	39.4664**	38.8525**	23.1164*	33.3042*	30.6809*	31.0659*
Degrees of freedom	(22)	(22)	(22)	(22)	(22)	(24)

Table 5-1 The Estimated Results Using Pooled Data

Type of households	A	B	C	D	E	F	G
Age of wife	20-29	20-29	30-39	30-39	30-39	30-39	30-39
Educational level	Senior high	Senior high	Junior high	Junior high	Senior high	Senior high	Senior high
No of children age 0 to 5	0	1+	0	1+	0	0	1+
No of children age 6 to 14	0	0	1+	1+	0	1+	1+
γ_1/σ	−0.210610*E*−2	−0.291112*E*−2	−0.738635*E*−2	−0.104590*E*−1	−0.274951*E*−2	−0.528854*E*−2	−0.220506*E*−3
	(1.9402)	(2.3350)**	(7.7598)**	(4.1094)**	(1.6538)	(6.3236)**	(0.1368)
γ_2/σ	−6.546196	−10.994171	−10.476751	−6.781215	−8.447696	−10.858538	−15.751899
	(2.1292)**	(2.7288)**	(6.8843)**	(1.9390)	(2.7331)**	(7.5718)**	(5.7725)**
γ_3/σ	0.382312*E*−2	0.351551*E*−2	0.116329*E*−2	0.137475*E*−2	0.136291*E*−2	0.152362*E*−2	0.225677*E*−2
	(14.9439)**	(14.6240)**	(7.7269)**	(3.8230)**	(4.1843)**	(13.1034)**	(9.7043)**
γ_4/σ	9.020178	5.789858	−2.748570	0.384755	−0.582128*E*−1	−1.180756	−0.335359
	(5.4106)**	(2.4536)**	(3.8028)**	(0.2348)	(0.0417)	(1.4811)	(0.2395)
γ_5/σ	−0.103266*E*−2	−0.582050*E*−3	0.357073*E*−3	0.516255*E*−4	0.510833*E*−4	0.176489*E*−3	0.103057*E*−3
	(5.3444)**	(2.1290)**	(4.2495)**	(0.2708)	(0.3151)	(1.8993)	(0.6335)
Number of iterations	19	4	2	3	6	3	3
χ^2	387.4443	68.8709	118.9529	37.0551*	94.1352	272.1064	66.4771**
Degrees of freedom	(35)	(41)	(47)	(39)	(37)	(49)	(41)
Emprical criterion	○	○	×	×	×	×	×

Table 5-2 The Estimated Results Using Pooled Data

Type of households	H	I	J	K	L	M
Age of wife	40-49	40-49	40-49	40-49	50-59	50-59
Educational level	Junior high	Junior high	Senior high	Senior high	Junior high	Senior high
No of children age 0 to 5	0	0	0	0	0	0
No of children age 6 to 14	0	1+	0	1+	0	0
γ_1/σ	−0.259501 E-2 (4.2540)**	−0.547033 E-2 (5.8890)**	−0.350976 E-2 (5.1642)**	−0.275108 E-2 (2.7879)**	−0.252213 E-2 (3.5342)**	−0.397389 E-3 (0.5321)
γ_2/σ	−11.304245 (13.0145)**	−8.490391 (7.2125)**	−12.851684 (13.6223)**	−13.330527 (10.7494)**	−10.470661 (9.4706)**	−8.509156 (6.2416)**
γ_3/σ	0.164326 E-2 (14.7320)**	0.142643 E-2 (9.7322)**	0.201579 E-2 (17.9528)**	0.217442 E-2 (15.6106)**	0.132008 E-2 (10.9470)**	0.118520 E-2 (9.8371)**
γ_4/σ	−1.509718 (7.8404)**	−0.628994 (2.4325)**	−1.425678 (5.7425)**	−0.591970 (1.8480)	−1.460791 (3.8573)**	−0.225613 (0.3803)
γ_5/σ	0.169899 E-3 (7.9828)**	0.851874 E-4 (2.9593)**	0.160051 E-3 (5.8157)**	0.662431 E-4 (1.8555)	0.208067 E-3 (4.8534)**	0.758730 E-4 (1.1253)
Number of iterations	2	2	3	3	2	3
χ^2	122.3540	79.6940	160.2053	139.4902	77.6887	103.6605
Degrees of freedom	(47)	(47)	(49)	(45)	(47)	(51)
Emprical criterion	×	×	×	×	×	×

Table 6-1 The Estimated Results of the Modified Model Using Pooled Data

Tape of households	A	B	C	D	E	F	G
Age of wife	20-29	20-29	30-39	30-39	30-39	30-39	30-39
Educational level	Senior high	Senior high	Junior high	Junior high	Senior high	Senior high	Senior high
No of children age 0 to 5	0	1+	0	1+	0	0	1+
No of children age 6 to 14	0	0	1+	1+	0	1+	1+
γ_1/σ	−0.999008E-2 (4.2644)**	−0.100022E-1 (3.0909)**	−0.136083E-1 (10.7724)**	−0.171781E-1 (5.0510)**	−0.939871E-2 (4.5932)**	−0.127791E-1 (11.6696)**	−0.693929E-2 (2.9297)**
α/σ	−51.994054 (3.6104)**	−53.821782 (2.9559)**	8.007482 (2.8548)**	8.620718 (1.3993)	28.155549 (4.2357)**	14.496896 (5.2181)**	3.656419 (0.6670)
β/σ	0.293028E-2 (3.2979)**	0.271717E-2 (2.3936)**	0.329102E-2 (7.7643)**	0.304581E-2 (2.9672)**	0.564711E-2 (6.0797)**	0.372532E-2 (10.4533)**	0.291733E-2 (4.1311)**
γ_3/σ	0.362119E-2 (14.0877)**	0.348457E-2 (14.5347)**	0.130900E-2 (8.6490)**	0.162439E-2 (4.4383)**	0.140638E-2 (4.2765)**	0.172905E-2 (14.7086)**	0.239440E-2 (10.1652)**
γ_4/σ	−21.510538 (2.2858)**	−22.380856 (1.8816)	9.924865 (5.5354)**	11.173978 (2.8194)**	25.268118 (5.8012)**	16.186057 (8.7168)**	12.652062 (3.6176)**
γ_5/σ	0.251475E-2 (2.3014)**	0.268917E-2 (1.9472)	−0.111911E-2 (5.3588)**	−0.120352E-2 (2.6101)**	−0.290453E-2 (5.7164)**	−0.181849E-2 (8.5332)**	−0.140691E-2 (3.4905)**
Number of iterations	19	7	3	3	5	3	3
χ^2	370.8490	65.9931**	58.0952*	29.4782*	55.5428*	170.2020	54.5352*
Degrees of freedom	(34)	(40)	(46)	(38)	(36)	(48)	(40)
Empirical criterion	×	×	O	O	O	O	O

Table 6-2 The Estimated Results of the Modified Model Using Pooled Data

Type of households	H	I	J	K	L	M
Age of wife	40-49	40-49	40-49	40-49	50-59	50-59
Educational level	Junior high	Junior high	Senior high	Senior high	Junior high	Senior high
No cf children age 0 to 5	0	0	0	0	0	0
No of children age 6 to 14	0	1+	0	1+	0	0
γ_1/σ	$-0.504120E-2$	$-0.864351E-2$	$-0.798255E-2$	$-0.840056E-2$	$-0.554084E-2$	$-0.426317E-2$
	(5.7883)**	(7.0914)**	(8.9394)**	(6.6598)**	(4.8459)**	(3.4264)**
α/σ	−9.208804	−5.814501	−7.757513	−6.978966	−6.062174	−0.820369
	(9.1222)**	(4.3769)**	(6.9612)**	(4.7439)**	(3.5477)**	(0.3501)
β/σ	$0.127750E-2$	$0.181639E-2$	$0.269773E-2$	$0.308605E-2$	$0.129508E-2$	$0.172905E-2$
	(3.7827)**	(4.0612)**	(7.7584)**	(7.1546)**	(3.3036)**	(3.9978)**
γ_3/σ	$0.172109E-2$	$0.155199E-2$	$0.223552E-2$	$0.239377E-2$	$0.135776E-2$	$0.127477E-2$
	(15.1603)**	(10.3719)**	(19.4038)**	(16.7032)**	(11.2024)**	(10.4632)**
γ_4/σ	−0.162540	1.208309	2.132879	3.555208	0.838701	3.942399
	(0.4002)	(2.3203)**	(4.0370)**	(5.3623)**	(1.0529)	(3.2631)**
γ_5/σ	$0.160278E-4$	$-0.124543E-3$	$-0.249897E-3$	$-0.409638E-3$	$-0.521819E-4$	$-0.398127E-3$
	(0.3476)	(2.1057)**	(4.1308)**	(5.4069)**	(0.5785)	(2.8974)**
Number of iterations	4	3	5	3	3	5
χ^2	107.5162	64.5632*	108.3923	91.3298	66.4893**	77.1098**
Degrees of freedom	(46)	(46)	(48)	(44)	(46)	(50)
Empirical criterion	×	○	○	○	○	○

Diagrammatic Exposition of Choice among Three Alternative Options for Labor Force Participation

Figure 1

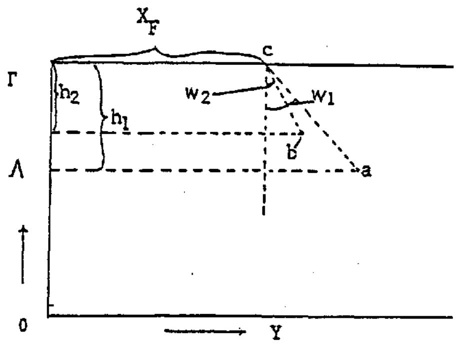


Figure 2

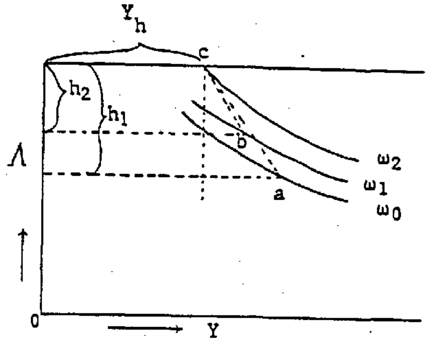


Figure 3

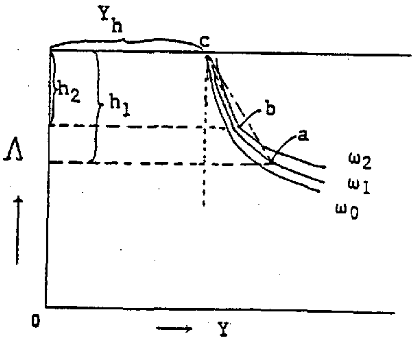
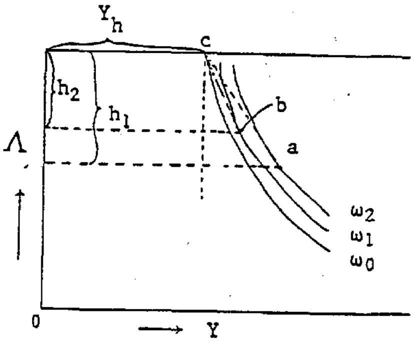


Figure 4



Notes: (1) The vertical axis (Λ) measures upward the amount of leisure time, and the horizontal axis (Y) measures income.

(2) Notations are: Y husband's(or household head's)income; h_1, designated hours for full-time work; h_2, designated hours for part-time work; w_2, hourly wage rate for full-time work; w_1, hourly wage rate for part-time work.

(3) ω_0 , ω_1 , ω_2 , indicate utility levels in descending order .

Figure 5. Diagrammatic Expression of Probability Density Function of the Value of a Parameter of Utility Function

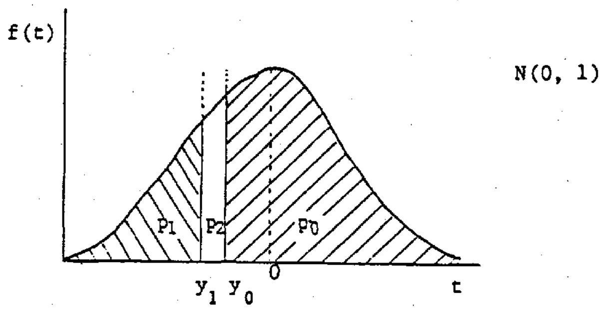
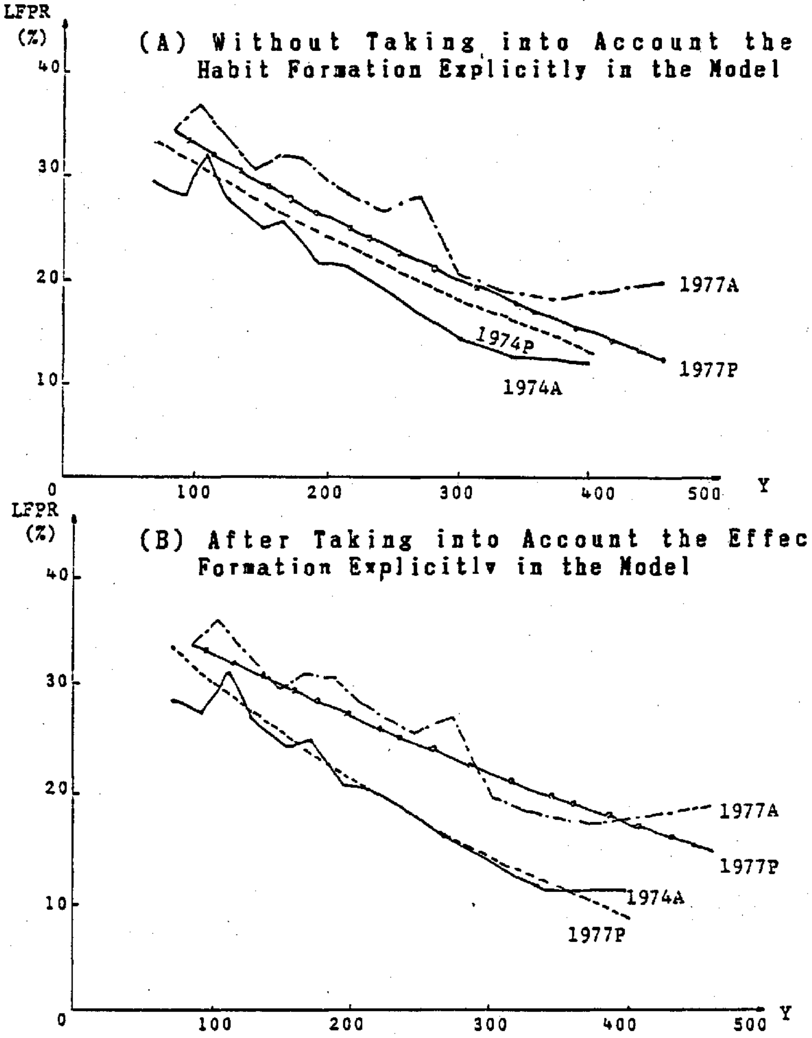


Figure 6. Actual and Predicted Relationships between Full-time Labor Force Participation Rate and Real Household Head's Income



Notes: (1)Vertical axis(LFPR) measures full-time labor force participation rate, and horizontal axis(Y) measures real household head's annual income in terms of 10 thousand yen.

(2)Notations on the graph, 1977A indicates actual values observed for 1977 and 1977P indicates predicted values computed on the basis of our result of estimation.

Figure 7-1 Simulation Results of Full-time Participation Ratios

Basic case: I=2million yen/year, w_1=730yen/hour, w_2=460yen/hour, h_1=2200hours/year, h_2=1500hours/year.

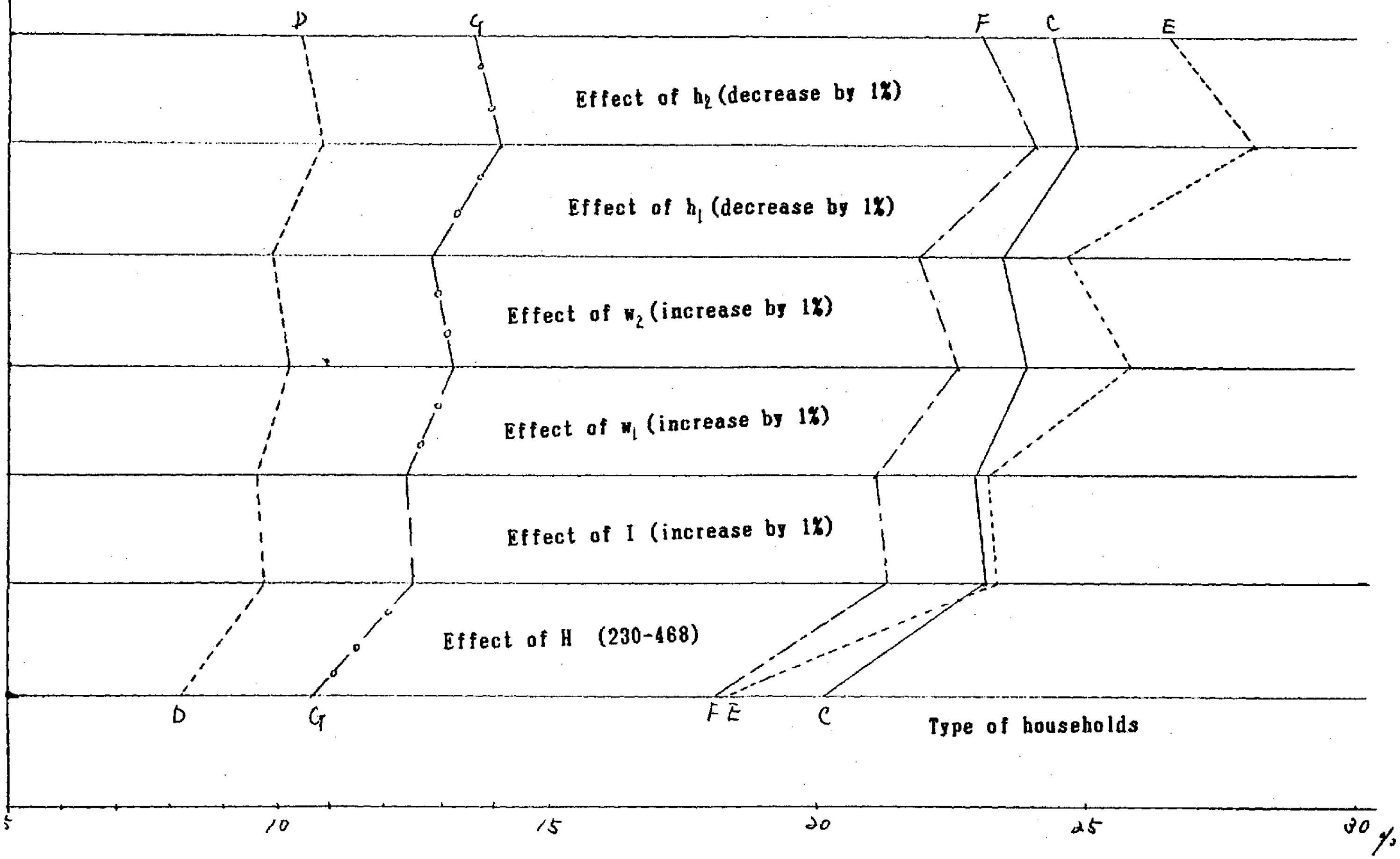


Figure 7-2 Simulation Results of Full-time Participation Ratios

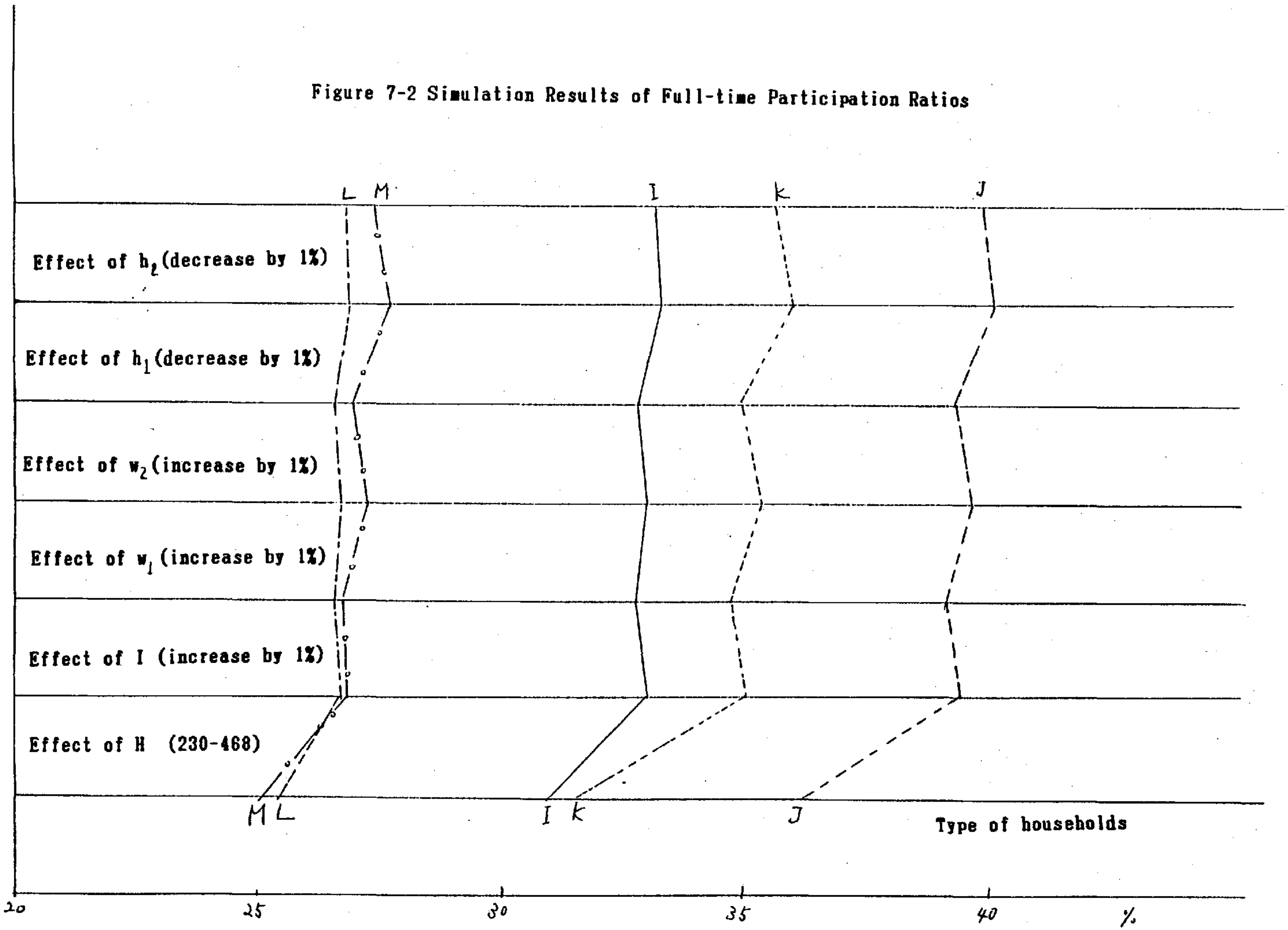


Figure 8-1 Simulation Results of Part-time Participation Ratios

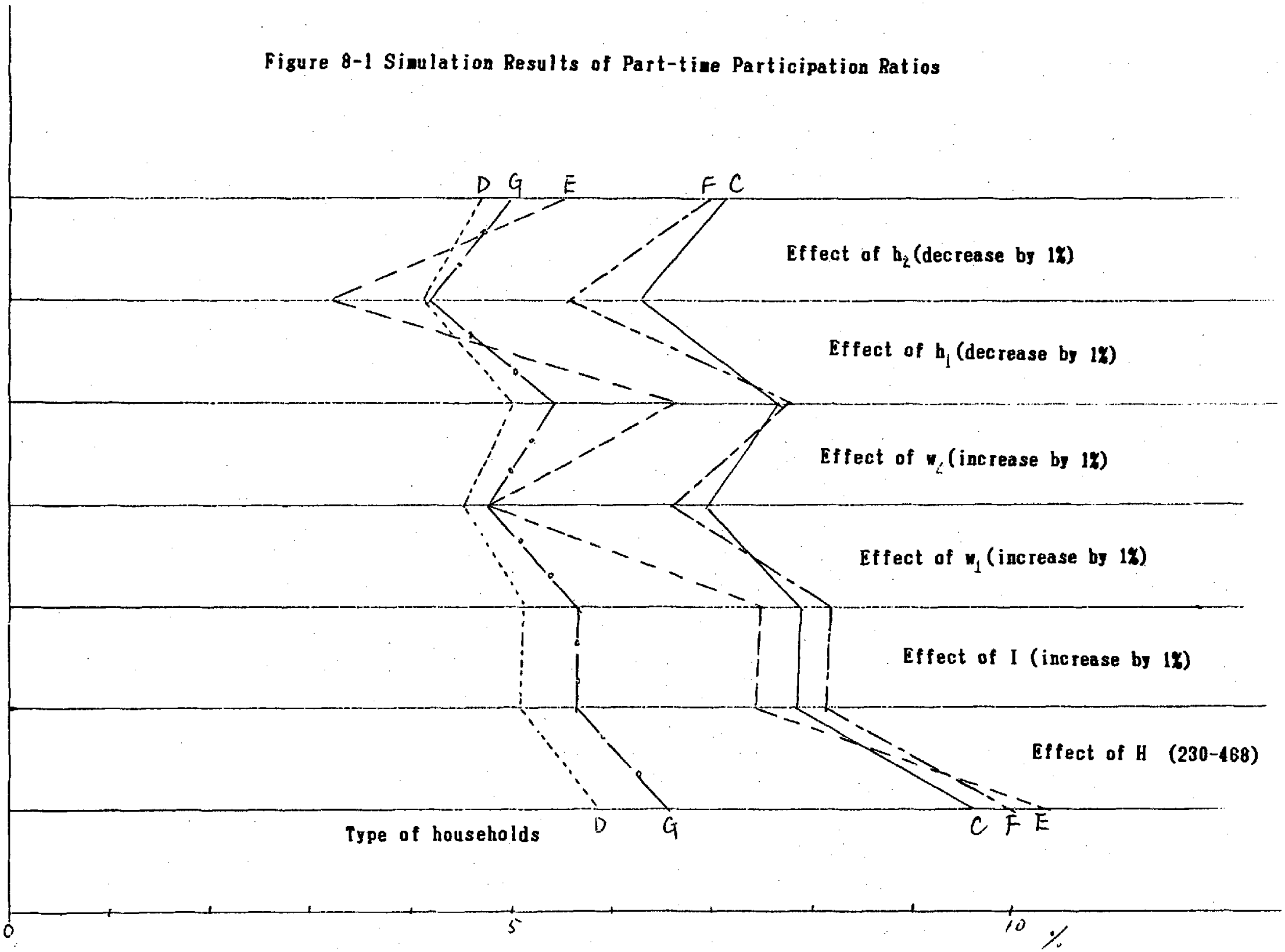


Figure 8-2 Simulation Results of Part-time Participation Ratios