Discussion Paper No. 554

EMPIRICAL RESEARCH ON THE DEMAND FOR INFLUENZA VACCINATION AMONG THE ELDERLY

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August 2001

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Empirical Research on the Demand for Influenza Vaccination Among the Elderly

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JEL Classifications: I11, I12, I18

Keywords: Influenza Vaccination, Actual Vaccination Rate, Conjoint Analysis, Joint Estimation, the Elderly as a High Risk Group

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Abstract

Purpose: This paper analyses what factors determine the demand for vaccination among the elderly as a high risk group. Using the estimation results, this paper then evaluates how legal requirements and/or subsidies affect their demand.

Methods: Original data were obtained from two surveys, conducted by the author, given to two groups: elderly people living with descendants, and elderly people living without descendants. The surveys contained information about the elderly, the household, experience of influenza during the last season, immunization during this time, and a hypothetical questionnaire about immunization for purposes of Conjoint Analysis. Three estimations are performed for actual behaviour, Conjoint Analysis and Joint Estimation, the latter combining the first two estimations.

Results: Among estimation results, factors such as cost, number of immunizations, availability of immunization at night or on the weekend, and legal requirements heavily affect the demand for immunization. Experience of influenza and immunization in the preceding season is one of the most important determinants. In addition, the superiority of the Joint Estimation method is confirmed.

Conclusions: The estimation results imply that about 8.9 million elderly people will have a demand for vaccination if there is no cost and it is legally recommended. If the cost is 6000 yen (about US$50) and there is no legal recommendation, demand for vaccination will be reduced to about 3.2 million elderly people. An increase in cost from free vaccination to just 500 yen (about US$4) depresses demand from 1.6 million elderly people. On its own, legal recommendations for vaccination can push up demand by 2.0 million elderly persons.

1 Introduction

In Japan, the influenza epidemic of the 1997-98 season was the most severe since influenza surveillance began in 1987. A total of 136,929 patients were clinically diagnosed with influenza by sentinel clinics, the highest number ever recorded. There were approximately 50,000 pneumonia and influenza deaths during this season. Each year in the U.S., 10 to 50 million individuals become ill with 'the flu'. In a typical year, approximately 20,000 of these individuals die from complications related to the disease.

To assess the severity of influenza epidemics, 'excess mortality', the number of deaths actually recorded in excess of the number expected on the basis of past seasonal experience has been used as a major index (Serfling (1963), Assad, Cockburn and Sundaresan (1973), Choi and Thacker (1981) for the US; and Tachibana, Kawaminami and Minowa (1999), Tachibana and Minowa (1999) for Japan). Shindo, Ii, Ohkusa and Taniguchi (2000) proposed a new method to forecast the expected number of pneumonia and influenza deaths. According to their method, excess mortality was 5,032 in January 1997, 2,820 in February 1998, and 6,798 in January 1999.

At present, vaccination is considered to be the best measure against influenza. Several studies have been conducted on the cost effectiveness of influenza vaccination (Nichol, Margolis, Wuorena and Sternberg (1994), Gross, Hermogenes, Sacks, Lau and Levandowski (1995), Levy (1996), Scott and Scott (1996)). Such discussions are useful where vaccination is compulsory. However, in most industrialized countries, including Japan, this is not the case. Consequently, it is necessary to investigate what factors determine the demand for vaccination. This aspect of influenza prevention has attracted little research attention so far, with the exceptions of Philipson (1996) and Mullahy (1999). Philipson (1996) examined the demand for measles vaccination using survival analysis to analyse the timing of vaccination, both during the epidemic and non-epidemic seasons. Mullahy (1999) estimated the demand for influenza immunization and the labour supply simultaneously, and showed that during the influenza outbreak of 1998, the probability of receiving immunization increased according to the level of education, insurance, and higher opportunity cost. However, Mullahy's use of a linear probability model and the applicability of the simultaneous estimation method are questionable.

The demand for influenza vaccination amongst adults less than 70 years old has already been investigated in Japan[12]. In that study, two approaches, analysis for the actual behaviour and conjoint analysis, were employed. In the actual behaviour analysis, past experience of influenza and the history of vaccination during the 1999-2000 season were found to be influential in the decision to be vaccinated. In the Conjoint Analysis, it was found that if the present vaccination fee of 6000 yen were to be waived, demand for vaccination would increase by 8.7 percentage points. If vaccination were provided at night and during weekends demand would increase by 2.1 percentage points, and if provided as well at workplaces and schools, it would increase by 3.2 percentage points.

The news of an influenza outbreak was also found to increase the demand for vaccination by 6.6 percentage points. Higher income, however, was found to reduce the demand for vaccination. This suggests that opportunity costs may be an influential factor in individuals' decisions on vaccination. Habit formation, revealed in vaccination history, also plays a quite important role in the demand for vaccination.

This paper extends the approach of the above study to the elderly, a high-risk group for influenza. Initially, the survey was completed separately by two groups, elderly people living with descendants, and elderly people living not living with their descendants. In particular, for elderly persons living with descendants, the hypothetical questionnaire for conjoint analysis was answered by their descendants or family. Hospital patients and nursing home residents were excluded by the purpose of this paper. Following completion of the surveys, actual behaviour, Conjoint Analysis, and Joint Estimation tests were performed. Joint Estimation, which combines the first two methods, was found to be the most reliable method[13,14].

2 Data

This paper is based on data from two separate surveys: elderly people living with descendants, and elderly people not living with their descendants.

2.1 Data for Elderly People with Descendants

The data for elderly people living with descendants was obtained from a survey conducted in May, 2001 in the Kanto (Tokyo, Kanagawa, Saitama, and Chiba prefectures) in eastern Japan, and the Kansai areas (Osaka, Kyoto, Nara, and Hyogo prefectures) in western Japan. Of a total of 1300 questionnaires distributed, 1024 were completed and returned. All these households voluntarily contracted with the survey firm to co-operate on various surveys. The households that were surveyed are randomly sampled by a two-step strata, but the decision to co-operate is, of course, not random. Therefore, particular attention should be paid to the sampling bias caused by this type of sampling. As no unemployed people and few self-employed responded to the survey, there is a small bias to richer households. However, these biases would be controlled by using such information as explanatory variables in the estimation rather than making simple comparisons about the average.

This sample contains 265 households and 338 elderly people. The questionnaire asks about age, gender, chronic illness, household income, assets, home ownership, history of vaccination, and experience of influenza during the last two seasons. In addition, it asks hypothetical questions about vaccination which were used in the conjoint analysis. Though hypothetical questions are completed by members of the elderly person's family, such as their descendants or housewives, they should reflect the elderly person's opinion.

2.2 Data for Elderly People Not Living With Their Descendants

The data for elderly people not living with their descendants were obtained from a survey conducted in June, 2001, covering the whole of Japan. Of the total 800 questionnaires distributed, 737 were completed and returned. These elderly people also voluntarily contracted with the survey firm to co-operate on various surveys. It should be noted that there is a sampling bias towards healthier elderly people, despite the fact that they are chosen randomly. Moreover, the sampling rate for more than 70 elderly persons or living in the rural area because they should be very few in the case of constant sampling rate. Of course, these unequal sampling rates should be taken into account in the summary statistics or estimation. While largely identical information is collected in the two surveys from the two types of households, the complexity of the questionnaire is reduced for elderly people not living with their descendants.

3 Summary Statistics

Table 1 summarizes the summary statistics for both types of households: the sample size is 338 in the group of elderly people with descendants, and 668 in the group of elderly people not living with their descendants . The vaccination rates in the '99/'00 season and '00/'01 season are 7.5% and 16.1%, respectively. The percentage rates for experiencing influenza, based on self-assessment, are 15.2

The significant difference in the experience rates of influenza based on each definition cannot be found. Needless to say, this difference is partly due to the endogenous choice made about whether to be vaccinated or not. Consequently, there is a selection bias which contaminates the true efficacy of the data.

In the group of elderly people living with their descendants, vaccination rates and the experience rate are almost the same. However, the experience rate for this group in the '99/'00 season based on a doctor's diagnosis is only 3.0%, which is about half of the experience rate for elderly persons not living with their descendants. The outbreak of influenza in that year emphasizes the difference between the two types of households. Of course, elderly people make an endogenous choice whether or not to live with their descendants. Consequently, simple comparison of the two types of households is meaningless because there is a selection bias. However, to analyse this selection, information about the descendants who live with the elderly people is required. Unfortunately, the collection of such information is very difficult and there are very few studies that examine this selection process explicitly. On the other hand, many research studies ignore that bias[15,16,17)]. Consequently, this paper does not deal with this selection process: that is, the decision whether or not to live with their descendants is considered to be exogenous, at least for the vaccination decision.

Tables 2 and 3 contain the simple average of the responses to the hypothetical questions. Note that the figure in Table 2, which represents the responses of elderly people living with their descendants, is not adjusted for the omitted attributes and thus is somewhat misleading. Conversely, Table 3, which represents the responses of elderly people not living with their descendants, contains all the information from the hypothetical questionnaires. While the questionnaires are different for the two types of household, free vaccination increases the demand by 5-10 times and it reaches about almost half. It is interesting that the demand for vaccination is higher when it costs 500 yen (about US$4), than in the case of free vaccination in the households not living with descendants. The effect of a legal recommendation to be vaccinated is surveyed only in the case of elderly people not living with their descendants. It increases the demand for vaccination by 20% points when vaccination is free, but it has no substantial effect when vaccination costs 2000 yen (about $16).

4 Analysis of Actual Demand

The dependent variable takes two values: $J_i = 1$ if a person i received, $J_i = 0$ if they did not. The independent variables are Spline function of Age $f(A_i)$, Gender ($G_i = 1$ if female, $G_i = 0$ if male), dummy variable C_i taking the value of one if a person has a history of chronic illness, household income (in logarithm) H_i, household net financial asset N_i, dummy variable M_i^1 taking the value of one if a person owns a house, dummy variable M_i^2 taking the value of one if a person owns an apartment, a dummy variable F_i taking the value of one if a person suffered from influenza during the last season, and finally a dummy variable W_i taking the value of one if a person received vaccination during the last season.

Empirical specifications are as follows:

$$\begin{aligned} J_i^* &= \alpha_0 + \alpha_A f(A_i) + \alpha_G G_i + \alpha_H H_i + \alpha_C C_i \\ &+ \alpha_N N_i + \alpha_{M^1} M_i^1 + \alpha_{M^2} M_i^2 + \alpha_F F_i + \alpha_W W_i + \varepsilon_i \\ J_i &= \begin{cases} 1 & \text{if } J_i^* > 0 \\ 0 & \text{otherwise} \end{cases} \end{aligned} \quad (1)$$

For the purpose of estimation, the probit method with heteroscedasticity consistent is adopted. The results of the estimation are presented in Table 4.

Though there are not so many significant variables in this table, vaccination in the last season is significant in both types of households. These marginal effects are very high at 76-83% points. The experience of influenza in the last season is significant in elderly people living with descendants and it rises 25% points. It is not significant in the group of elderly people not living with their descendants. Almost all other variables like age or chronic illness. On average, after taking into account other characteristics, the vaccination rate of elderly couples is 8.5%points less than for single elderly people, even in the group not living with their descendants.

5 Conjoint Analysis

5.1 A Brief Explanation of Conjoint Analysis

This study utilizes a technique called Conjoint Analysis, which attempts to elicit people's preference for programme benefits. In different hypothetical situations, respondents are given various options and select their most preferred choice. Conjoint Analysis uses various hypothetical situations and individual characteristics as independent variables, and choices as dependent variables to estimate the statistical model. In addition, Conjoint Analysis measures the change in utility.

In seeking measures of preference in the hypothetical contexts, approaches that have commonly been used in health care include standard gamble and time trade-off. These techniques tend to concentrate on obtaining preference values for health conditions, which are then used as weights for the adjustment of life years in the calculation of quality-adjusted life years (QALYs). In addition, willingness-to-pay techniques have also been used to obtain monetary valuations for programme benefits in the hypothetical context in health care. Conjoint Analysis, which uses peoples' statements of how they would respond to different hypothetical situations, is an alternative approach to obtaining preferences for programme benefits. Such methods are increasingly being adopted in the health care sector. Most studies pose questions on opinions on the introduction of new medical technologies, such as in-vitro fertilization (Ryan (1999)), orthodontic services (Farrar and Ryan (1999)), abortion technology (Ryan and Hughes(1997)), blood transfusion (Van der Pol and Cairns (1997)) and the use of MRI for the investigation of knee injuries (Bryan et al. (1998)). In Japan, however, very few studies have employed the Conjoint Analysis method (Ohkusa (2000)).

Although Conjoint Analysis may be a better method than the conventional ones, there remains a possibility of bias arising from two sources: hypothetical choice and hypothetical scenarios. Ohkusa (2000) shows that both biases are fairly significant, particularly the conspicuous bias arising from the hypothetical scenarios. The analysis of these biases and the method of controlling them is an important issue in future research.

For Conjoint Analysis, a probit estimation method with random effect is used. Since the dependent variable takes the value of one or zero, probit estimation is a basic method. The random effects approach was chosen as it treats the individual effects as being uncorrelated with other independent variables, and allows adjustment for the panel nature of the data.

For Conjoint Analysis, different questionnaires were adopted for elderly people living with their descendants and for elderly people not living with their descendants. In the surveys of elderly people living with their descendants, there are four attributes, which are set as number of times immunized, cost, prevalence, and convenience, which refers to when and where it is possible to be immunized. In addition, there are two to four conditions attached to each attribution. These include:

Times: once or twice

Cost: free, 1500 yen (about US$12) per shot, or 3000 yen (about US$24) per shot

Prevalence: yes or no

Accessibility : vaccination at the medical institution during the day time, vaccination at the medical institution at night or during the weekend, vaccination at an accessible place other than a medical institution, or vaccination at home.

Consequently, there are 48 hypothetical cases. Each respondent is asked 10 cases, in which there are 5 patterns, and thus in total 50 cases are covered.

On the other hand, for elderly persons not living with their descendants, the hypothetical questions include would you like to receive an influenza vaccination if

Scenario 1: The law recommends immunization and the cost is 5000 yen (about US$40)

Scenario 2: The law recommends immunization and the cost is 2000 yen (about US$16)

Scenario 3: The law recommends immunization and the cost is 500 yen (about US$4)

Scenario 4: The law recommends immunization and it is free

Scenario 5: The law does not recommend immunization and the cost is 5000 yen (about US$40)

Scenario 6: The law does not recommend immunization and the cost is 2000 yen (about US$16)

Scenario 7: The law does not recommend immunization and the cost is 500 yen (about US$4)

Scenario 8: The law does not recommend immunization and the cost is free

At present the cost is about 3000 yen (about US$24 dollars) per shot, one shot is required which can be received from a medical institution during the daytime, though there is no legal recommendation to be immunized. Whether influenza is prevalent or not is a subjective question to the respondent. In the last season, it was seen to be of moderate prevalence.

5.2 Estimation using Conjoint Analysis

The dependent variable takes two values: $J_{i,j}$. under the jth hypothetical situation. The independent variables are the variables in addition to those used in equation (1), prices P_i under hypothetical situations (in logarithm), a dummy variable R_j^1 which takes the value of one if vaccination is available anytime, a dummy variable R_j^2 which takes the value of one if vaccination is available at an accessible place, R_j^3 which takes the value of one if vaccination is available at home, a dummy variable K_j which takes the value of one if influenza is prevalent, and finally, L_j which takes the value of one if the law recommends immunization.

Consequently, the empirical specification is

$$\begin{aligned} J^*_{i,j} &= \beta_i + \beta_P \log P_j + \beta_{R^1} R_j^1 + \beta_{R^2} R_j^2 + \beta_{R^3} R_j^3 + \beta_K K_j + \beta_L L_j \\ &+ \beta_A f(A_i) + \beta_G G_i + \beta_H H_i + \beta_N N_i \\ &+ \beta_C C_i + \beta_{M^1} M_i^1 + \beta_{M^2} M_i^2 + \beta_W W_i + \beta_F F_i + \beta_E E_i + \varepsilon_i^j \\ J_{i,j} &= \begin{cases} 1 & \text{if } J^*_{i,j} > 0 \\ 0 & \text{otherwise} \end{cases} \end{aligned} \qquad (2)$$

where β_i is a random variable following $N(0, \sigma_\beta^2)$ and represents the individual effect. For estimation, the probit method with random effect is used. With 10/8 hypothetical situations, the maximum size of j is 10/8, although some did not answer all questions. Therefore, we were not able to observe 18 samples for each respondent. Estimation results are shown in Table 5.

The cost is significantly negative. When the cost is reduced from the current level of 6000 yen (about $24) in two shots, and made free of charge, the vaccination rate would increase by 22-32% points. If the number of shots required is reduced from two to one, vaccination rates rise by 14% points. If vaccination is available at any time, the rate wouldincrease by 34% points, but vaccination at an accessible place or at home does not contribute to an increase in the vaccination rate. Prevalence does not influence the rate. On the other hand, if the law enforces immunization it increases by 9.5% points.

In other variables under the hypothetical question, the vaccination and experience of influenza in the last season are positive and significant, as in Table 4. Moreover, the marginal effect of the vaccination in the last season reached 43-62% points. The experience of influenza in the last season is significant and its marginal effect is about 12%points. However, it is not significant amongst elderly people living with their descendants.

6 Analysis using Joint Estimation

So far, the actual behaviour and conjoint analysis have been estimated separately, but these two data set have advantages and disadvantages. For example, although the actual behaviour is objective and amenable to analysis, it does not contain information about the effect of cost or other policy variables. In addition, it cannot be determined which individual effect would be the most important determinant of the behaviour. Joint estimation[13,14)] is proposed to overcome the problems of using these two approaches. Specifically, on the one hand, joint estimation uses the same coefficients on the common variables as the other two approaches, such as age, gender and chronic illness, and on the other hand, it estimates the effect of the hypothetical situation. In this way, it excludes extreme responses to the hypothetical situation and thus provides a more reliable estimator for cost and/or other policy variables. The estimation equation is as follows:

$$
\begin{aligned}
J^*_{i,j,k} &= \gamma_i + \gamma_P \log P_j + \gamma_{R^1} R^1_j + \gamma_{R^2} R^2_j + \gamma_{R^3} R^3_j + \gamma_K K_j + \gamma_L L_j \\
&+ \gamma_A f(A_i) + \gamma_G G_i + \gamma_H H_i + \gamma_N N_i \\
&+ \gamma_C C_i + \gamma_{M^1} M^1_i + \gamma_{M^2} M^2_i + \gamma_W W_i + \gamma_F F_i + \gamma_E E_i + \gamma_{CJ} CJ_k + \varepsilon_{i,j,k} \\
J_{i,j_k} &= \begin{cases} 1 & \text{if } J^*_{i,j,k} > 0 \\ 0 & \text{otherwise} \end{cases}
\end{aligned} \tag{3}
$$

where k denotes whether this data comes from actual behaviour or Conjoint Analysis, and CJ_k is the dummy variable for Conjoint Analysis data. γ_i is a random effect like β_i in Eq.(2), but is also included even in the actual behaviour data.

The estimation results are summarized in Table 6. This shows that the estimators for hypothetical situations like cost are almost the same as in Table 5. In this sense, the estimates provided by Conjoint Analysis are as reliable as the Joint Estimation, at least in this estimation.

Under Joint Estimation, the effect of vaccination in the last season decreases to 37-22% points, which is the lowest in the three estimation procedures. The past experience of influenza is significant for both types of households and its impact is 12-19% points. This figure is close to the actual behaviour estimate for elderly persons living with their descendants, and, conversely, it is close to the Conjoint Analysis estimate for elderly persons not living with their descendants. Thus, the figure shows how the Joint Estimation method avoids the extreme estimator.

In regard to chronic illness, the number of significant coefficients in Joint estimation is the highest of the three estimations. Cardiovascular disease is significant and positive in elderly people living with their descendants, and nervous, sensorium, and other chronic illness are significant in elderly people not living with their descendants. This finding also indicates the advantages of Joint estimation, as these are not significant in the estimation in the actual behaviour or Conjoint Analysis. In Need for Assistance increases the rate by 11%points, which is the same in Table 5.

7 Pooling Estimation for Both Types of Household

In addition, Joint estimation is applied to the pooled data for both household types. We can discuss household types and demand forecasts via this method of pooling

Let t be the subscription for the household type. Then the estimation equation is:

$$\begin{aligned} J^*_{i,j,k,t} &= \eta_i + \eta_P \log P_j + \eta_{R^1} R^1_j + \eta_{R^2} R^2_j + \eta_{R^3} R^3_j + \eta_K K_j + \eta_L L_j \\ &+ \eta_A f(A_i) + \eta_G G_i + \eta_H H_i + \eta_N N_i \\ &+ \eta_C C_i + \eta_{M^1} M^1_i + \eta_{M^2} M^2_i + \eta_W W_i + \eta_F F_i + \eta_E E_i + \eta_C C_k \\ &+ \eta_A f(A_i) + \eta_G G_i + \eta_H H_i + \eta_N N_i \\ &+ Z_t(\eta^t + \eta^t_P \log P_j + \eta^t_C C_i + \eta^t_{M^1} M^1_i + \eta^t_{M^2} M^2_i + \eta^t_W W_i + \eta^t_F F_i + \eta^t_E E_i + \eta^t_C C_k) \\ &+ \varepsilon_{i,j,k} \\ J_{i,j_k,t} &= \begin{cases} 1 & \text{if } J^*_{i,j,k,t} > 0 \\ 0 & \text{otherwise} \end{cases} \end{aligned} \tag{4}$$

where Z_t is the dummy variable for elderly people not living with their descendants. This specification means that the coefficients of the hypothetical situation, other than cost, are assumed to be the same among the type of households, while cost and other characteristics of households or elderly persons can differ. Estimation results are summarized in Table 7. Note that the number in the column labelled "elderly persons not living with their descendants" does not have the same meaning as in other tables and indicates the difference between the coefficients of elderly people not living with their descendants and those of elderly people living with their descendants.

Table 7 shows that cost is more inelastic, i.e. its marginal effect is -0.022 for elderly persons not living with their descendants, and -0.036 for elderly persons living with their descendants. Other coefficients are very similar to the non-pooled estimations. For example, although the dummy variable for household types is not significant, there are significant differences among types in chronic illness as with the Conjoint dummy variable. In particular, as in Table 6, elderly persons not living with their descendants showed a smaller gap between actual behaviour and Conjoint Analysis than for elderly persons living with their descendants.

8 Simulation for Vaccination Demand

Finally, we attempt to simulate and forecast the vaccination demand. Incidentally, in 1998 there were 20.62 million elderly persons over 65 years of age, of which 11.22 million lived with their descendants and 9.39 million did not live with their descendants.

Since there are many policy variables in the hypothetical questionnaire, to avoid an overly complex presentation, the simulation relates only to the two factors which most concern policy: the cost of vaccination, and whether or not it is a legal requirement. Other factors in the hypothetical situations are assumed to remain constant - it is assumed that only one shot is necessary, which is given at a medical institution during the daytime, and that there is no prevalence. These assumptions basically represent the current situation. Other variables outside the hypothetical situation, such as age, gender and chronic illness, are assumed to obey the actual distribution of the sample data, which means it is assumed that the sample distribution is representative.

Simulation results are summarized in Table 8 with a 90% confidence interval. The table shows that when cost is 6000 yen (about $48 dollars) and there is no legal recommendation for vaccination, the number of elderly persons who were immunized is the lowest, 3.22 million. This is believed to be the current situation. When vaccination is free of charge and recommended by the law, the number of elderly persons vaccinated increases dramatically to 8.93 million, or about 40% of elderly persons.

However, when the cost increases to 500 yen (about \$4), 1.6 million elderly persons are discouraged from immunization. On the other hand, if vaccination is recommended by law, even if the cost is not reduced, 2 million elderly persons are encouraged to be immunized.

9 Concluding Remarks

This paper examines the demand for influenza vaccination in Japan by elderly persons, which are a high-risk group. Original data were obtained from a survey conducted by the author. Three approaches, actual behaviour, conjoint analysis, and joint estimation, which combines the first two approaches, were employed. The results provide many interesting points and reliable policy recommendations.

However, some remarks should be noted on interpretation of the data. First, the research basis of the survey may be contaminated by the sampling bias. In particular, it does not survey inpatients and residents in institutions. In addition, even if they live at home, weak and unhealthy elderly persons may not have been included in the survey. In general, it is not well known whether this group is likely to be immunized or whether their demand for vaccination has a low price elasticity. To answer this problem, the survey should be extend to this group, but a mailing survey may not be appropriate for this purpose.

Secondly, even if joint estimation techniques are adopted, which can exclude extreme responses to hypothetical situations, it is not clear how these could be successfully utilised. A gap may remain between actual behaviour and the hypothetical situation. This can only be resolved by conducting further surveys and analysis, which will provide more reliable estimators. There remains a need for further research.

Acknowledgement

This paper is a combination of two independent research projects. The research for elderly persons not living with their descendants is one part of a research project financed by the Japanese Ministry of Labour, Health and Welfare (2001 Scientific Research Grant, titled "The Research for the Forecast of Vaccination Demand for Influenza", headed by Prof. Yoshihiko Miura of Saitama Prefecture University). The other research project concerning elderly persons living with their descendants is part of a project financed by the Japanese Ministry of Education and Science (2000 Scientific Research Grant, titled "Evaluation for Economic Institution Based on Empirical Research for Household Behavior" (grant number:12124207), headed by Prof. Fumio Hayashi of Tokyo University. I am grateful for the comments of the participants in the projects. I would also like to acknowledge helpful suggestions from Kiyosu Taniguchi and Nahoko Shindo at the National Institute for Infectious Diseases. In addition, I would like to acknowledge the assistance provided by Kazuko Matsumoto.

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Table 1: Summary Statistics

	with descendants	without descendants
Vaccination('99/'00)	.0757576	.0752212
Vaccination('00/'00)	.1449704	.1617021
Influenza Experience		
Self Assessment('99/'00)	.1615854	.1525926
Self Assessment('00/'01)	.1397516	.1101322
Diagnosis('99/'00)	.0304878	.0681481
Diagnosis('00/'01)	.0310559	.0368189
Age	71.10853	70.15875
Female dummy	.4571429	.4966079
Respiratory Chronic Illness	.121447	.0556309
Digestive Chronic Illness	.1111111	.1451832
Cardiovascular Chronic Illness	.3333333	.256445
Nervous Chronic Illness	.0981912	.0257802
Muscular and Skeletal Chronic Illness	.3436693	.1478969
Unitary Chronic Illness	.0723514	.0597015
Endocrine Chronic Illness	.2609819	.202171
Sensorium Chronic Illness	.2325581	.2035278
Other Chronic Illness	.3229974	.0257802
In Need for Assistance		.0502035
Household Income (in log)	5.99161	5.121297
Net Financial Asset	676.615	1412.687
Real Asset (Home)	.8191214	.8276798
Real Asset (Apartment)	.0930233	.0759837
Single Elderly Person		
Elderly Couples		.8680556
Elderly persons with Descendants	1	.0208333
Other Household		.0083333
Big City	.3747	.2551
Medium City	.0310	.1493
Small City	.5504	.4518
Rural	.0439	.1343
Farm Village		.0095

Table 2: Conjoint Analysis of Vaccination for Elderly Persons Living with Descendants (Simple Average)

Conditions	
Number of Shots	
Once	.3954545
Twice	.3097913
Cost per Shot	
3000 yen	.2597701
1500 yen	.3448276
Free	.4624697
Prevalence	
No	.2237237
Yes	.4943274
Accessibility	
Current	.3638743
Night/Weekend	.3299663
Other Places	.3449367
At Home	.375

Table 3: Conjoint Analysis of Vaccination for Elderly Persons Not Living with Descendants

Legal recommendation	Cost (Yen)	Vaccination Rate
Yes	5000	.0758929
	2000	.4061433
	500	.7437186
	Free	.6881188
No	5000	.1013216
	2000	.4285714
	500	.6131805
	Free	.4829268

Table 4: Estimation Results for Actual Behaviour

	with descendants		without descendants	
	Marginal Effect	p value	Marginal Effect	p value
Age	.0067135	0.562	.0101318	0.240
(Age - 70)1[Age $\geq$ 70]	-.0170941	0.469	-.013802	0.367
(Age - 75)1[Age $\geq$ 75]	.0009228	0.978	.0183957	0.363
(Age - 80)1[Age $\geq$ 80]	.0123913	0.769	-.01073241	0.592
(Age - 85)1[Age $\geq$ 85]	-.0322048	0.463	-.01073241	0.592
Female du1[Age $\geq$ 90]	-.0027124	0.937	.0366968	0.191
Respiratory Chronic Illness	-.0435962	0.440	.037826	0.476
Digestive Chronic Illness	-.0059544	0.913	.0035925	0.916
Cardiovascular Chronic Illness	.0446591	0.255	.0519703	0.102
Nervous Chronic Illness	-.0131215	0.793	.0374057	0.680
Muscular and Skeletal Chronic Illness	-.0109033	0.767	.044014	0.223
Unitary Chronic Illness	.0471642	0.451	.0884861	0.108
Endocrine Chronic Illness	-.0153965	0.692	.0998169	0.003
Sensorium Chronic Illness	-.0344334	0.447	.0073932	0.810
Other Chronic Illness	.0004998	0.990	-.067304	0.079
In Need for Assistance			-.0076047	0.907
Influenza Experience	.2780875	0.000	.0364175	0.357
Vaccination Experience	.7553172	0.000	.8339464	0.000
Household Income (in log)	.0043047	0.593	-.0037152	0.682
Net Financial Asset	-2.02e-06	0.846	-9.50e-06	0.273
Real Asset (Home)	.0788892	0.131	.016572	0.706
Real Asset (Apartment)	.052781	0.639	.1109919	0.136
Elderly Couples			-.0851013	0.070
Elderly persons with Descendants			.0346669	0.688
Medium City	.0357897	0.692	-.0203777	0.564
Small City	.0058377	0.880	-.0127894	0.675
Rural			.0173722	0.684

Note: The likelihood ratio test for all coefficients except for the constant term which is zero for elderly persons living with their descendants are rejected at 1% significance level. Its log likelihood is -82.791 and pseudo R^2 is 0.3031. The likelihood ratio test for all coefficients except for the constant term which is zero for elderly persons not living with descendants are rejected at 1% significance level. Its log likelihood is -151.54 and pseudo R^2 is 0.3657.

Table 5: Estimation Results for Conjoint Analysis

	with descendants		without descendants	
	Marginal Effect	p value	Marginal Effect	p value
Cost(in log)	-.02522089	0.000	-.03677605	0.000
Two Shots Dummy	-.14276516	0.000		
Shot at Night or Weekend Dummy	.34337536	0.000		
Shot at Accessible Place	.00893647	0.814		
Shot at Home	-.04432643	0.224		
Prevalence Dummy	.00534984	0.891		
Legal Recommendation			.09498724	0.000
Age	.0362586	0.164	.00082562	0.940
(Age - 70)1[Age $\geq$ 70]			-.0103762	0.604
(Age - 75)1[Age $\geq$ 75]	-.07922911	0.091	.01283505	0.674
(Age - 80)1[Age $\geq$ 80]	.04564262	0.387	.02290995	0.637
(Age - 85)1[Age $\geq$ 85]	.06334376	0.317		
(Age - 90)1[Age $\geq$ 90]	-.08105918	0.261		
Female dummy	-.00112939	0.990	.0303149	0.345
Respiratory Chronic Illness	-.09629074	0.452	-.11666444	0.063
Digestive Chronic Illness	-.07912406	0.391	.02229562	0.627
Cardiovascular Chronic Illness	.06743487	0.306	.00888117	0.796
Nervous Chronic Illness	-.10955807	0.150	.27131134	0.034
Muscular and Skeletal Chronic Illness	.11335961	0.148	-.00771539	0.855
Unitary Chronic Illness	.07793709	0.422	.06497005	0.308
Endocrine Chronic Illness	.02870001	0.711	.00743586	0.846
Sensorium Chronic Illness	-.11174018	0.150	.05051267	0.210
Other Chronic Illness	-.04287212	0.561	.19054796	0.176
In Need for Assistance			.11989901	0.098
Influenza Experience	.01551211	0.885	.11571933	0.005
Vaccination Experience	.61963421	0.000	.43626562	0.000
Household Income (in log)	.0066106	0.714	-.00585357	0.647
Net Financial Asset	.00001227	0.505	.00001175	0.294
Real Asset (Home)	-.12492886	0.332	-.08429571	0.136
Real Asset (Apartment)	-.00025391	0.999	-.10049675	0.180

Elderly Couples			-.00468678	0.931
Elderly persons with Descendants		.	.03410025	0.780
Other Household			-.16169356	0.402
Medium City	.15525582	0.437	.03815038	0.465
Small City	.06028977	0.372	.06095812	0.118
Rural	.35386404	0.049	.01307271	0.813
Farm Village			-.04240934	0.601

Note: The sample size of elderly persons living with their descendants is 144 individuals and 1283 samples. The likelihood ratio test for all coefficients except for the constant term is zero in this case. The sample size of the group of elderly persons not living with their descendants is 700 individuals and 2557 samples. The likelihood ratio test for all coefficients, except for the constant term which is zero, is rejected at 1% significance level.

Table 6: Joint Estimation among Actual Behaviour and Conjoint Analysis

	with descendants		without descendants	
	Marginal Effect	p value	Marginal Effect	p value
Cost(in log)	-.02438339	0.000	-.03589957	0.000
Two Shots Dummy	-.13432005	0.000		
Shot at Night or Weekend Dummy	.33165383	0.000		
Shot at Accessibility Place	.01282752	0.723		
Shot at Home	-.03727379	0.276		
Prevalence Dummy	.00990128	0.786		
Law Recommendation			.09475876	0.000
Age	.0075168	0.736	.00230228	0.812
(Age - 70)1[Age $\geq$ 70]	.01453093	0.699	-.00958017	0.596
(Age - 75)1[Age $\geq$ 75]	-.05203914	0.204	.01699283	0.538
(Age - 80)1[Age $\geq$ 80]	.0160218	0.754	-.02005843	0.615
(Age - 85)1[Age $\geq$ 85]	.05284339	0.391		
(Age - 90)1[Age $\geq$ 90]	-.05539586	0.402		
Female dummy	.06417374	0.290	-.00828369	0.778
Respiratory Chronic Illness	-.09595305	0.313	-.05999469	0.335
Digestive Chronic Illness	-.09708313	0.252	.01960893	0.637
Cardiovascular Chronic Illness	.08529077	0.097	.03668624	0.251
Nervous Chronic Illness	-.07076987	0.349	.27624604	0.000
Muscular and Skeletal Chronic Illness	.08061989	0.173	-.01111679	0.780
Unitary Chronic Illness	.146584	0.114	.08578814	0.127
Endocrine Chronic Illness	.04467399	0.441	.04232854	0.228
Sensorium Chronic Illness	-.04014177	0.522	.06506282	0.069
Other Chronic Illness	-.0361404	0.540	.15032881	0.069
In Need for Assistance			.1095157	0.070
Influenza Experience	.16867374	0.017	.12428474	0.000
Vaccination Experience	.36870903	0.000	.22118837	0.000
Household Income (in log)	.00474678	0.755	-.005132	0.658
Net Financial Asset	7.209e-06	0.633	6.338e-06	0.534
Real Asset (Home)	-.0370723	0.702	-.07369098	0.149
Real Asset (Apartment)	-.06185246	0.624	-.06226342	0.365

Elderly Couples			-.02452867	0.629
Elderly persons with Descendants			.03124743	0.794
Other Household			-.22222303	0.282
Medium City	.0886554	0.565	.02670482	0.575
Small City	.03478028	0.538	.05346023	0.134
Rural	.15519883	0.250	.0080299	0.868
Farm Village			-.0707356	0.301
Conjoint Dummy	.27317652	0.000	.5945397	0.000

Note: The sample size of elderly persons living with descendants is 328 individuals and 1590 samples. The likelihood ratio test for all coefficients except for the constant term is zero in this case. The sample size of elderly persons not living with descendants is 718 individuals and 3185 samples and its likelihood ratio test for all coefficient except for constant term is zero for the elderly persons living without descendants are rejected at 1% significant level.

Table 7: Joint Estimation on the Pooled among Household Types

	with descendants		without descendants	
	Marginal Effect	p value	Marginal Effect	p value
Cost (in log)	-.02255168	0.000	-.01409002	0.003
Two Shots Dummy	-.12342393	0.000		
Shot at Night or Weekend Dummy	.30599144	0.000		
Shot at Accessibility Place	.01249799	0.708		
Shot at Home	-.0340722	0.282		
Prevalence Dummy	.00967683	0.774		
Legal Recommendation			.09732786	0.000
Age	.00797087	0.703	-.00592108	0.797
(Age - 70)1[Age $\geq$ 70]	.01254973	0.722	-.0220246	0.579
(Age - 75)1[Age $\geq$ 75]	-.0488111	0.206	.06603176	0.165
(Age - 80)1[Age $\geq$ 80]	.01444977	0.765	-.03394031	0.590
(Age - 85)1[Age $\geq$ 85]	.05020476	0.390		
(Age - 90)1[Age $\geq$ 90]	-.05156333	0.408		
Female dummy	.0656891	0.245	-.07540935	0.238
Respiratory Chronic Illness	-.08603337	0.334	.02372582	0.827
Digestive Chronic Illness	-.09906714	0.220	.11901429	0.191
Cardiovascular Chronic Illness	.07969082	0.101	-.04231704	0.468
Nervous Chronic Illness	-.06638294	0.359	.34596825	0.001
Muscular and Skeletal Chronic Illness	.07496171	0.178	-.08564496	0.212
Unitary Chronic Illness	.14671101	0.098	-.05977958	0.570
Endocrine Chronic Illness	.04251697	0.436	-.00063726	0.992
Sensorium Chronic Illness	-.03192429	0.589	.09709249	0.161
Other Chronic Illness	-.03353948	0.548	.18539838	0.069
In Need for Assistance			.11277641	0.064
Influenza Experience	.30999771	0.001	-.04607038	0.648
Vaccination Experience	.16526113	0.013	-.04014137	0.593
Household Income (in log)	.00451159	0.755	-.00986377	0.596
Net Financial Asset	5.266e-06	0.710	1.557e-06	0.929
Real Asset (Home)	-.03900807	0.673	-.03267661	0.758
Real Asset (Apartment)	-.07345112	0.535	.0116132	0.933

Elderly Couples			-.02373158	0.643
Elderly persons with Descendants	.58472371	0.709	.03512046	0.772
Other Household			-.22844841	0.275
Medium City	.08098421	0.574	-.05477642	0.718
Small City	.02960441	0.578	.0238345	0.711
Rural	.13517834	0.290	-.12904885	0.346
Farm Village	-.06888663	0.314		
Conjoint Dummy	.25660342	0.000	.34807029	0.000

Note: The sample size is 1046 individuals and 4775 samples. The likelihood ratio test for all coefficient except for the constant term are zero.

Table 8: Forecast for Demand of Vaccination and its 95%CI (Million Elderly Persons)

Legal Recommendation	No			Yes		
Cost	Lower bound	Average	Upper bound	Lower bound	Average	Upper bound
Living with Descendants						
Free	2.687	3.006	3.344	3.617	3.985	4.366
500	1.472	2.005	2.274	2.134	2.803	3.129
1000	1.366	1.909	2.169	1.996	2.684	3.003
1500	1.307	1.854	2.110	1.919	2.616	2.931
2000	1.265	1.816	2.068	1.865	2.569	2.880
2500	1.234	1.786	2.036	1.824	2.532	2.841
3000	1.209	1.763	2.010	1.791	2.503	2.809
3500	1.188	1.743	1.989	1.763	2.478	2.783
4000	1.170	1.726	1.970	1.739	2.456	2.760
4500	1.155	1.711	1.953	1.719	2.437	2.739
5000	1.141	1.697	1.939	1.700	2.421	2.721
5500	1.129	1.685	1.926	1.684	2.405	2.705
6000	1.117	1.675	1.914	1.669	2.392	2.690
Living without Descendants						
Free	3.624	3.967	4.318	4.592	4.947	5.301
500	1.589	2.113	2.386	2.277	2.913	3.231
1000	1.421	1.943	2.203	2.065	2.710	3.018
1500	1.328	1.847	2.100	1.946	2.594	2.897
2000	1.265	1.781	2.028	1.865	2.514	2.812
2500	1.218	1.731	1.974	1.803	2.452	2.747
3000	1.180	1.691	1.930	1.754	2.402	2.694
3500	1.148	1.657	1.893	1.713	2.361	2.650
4000	1.122	1.628	1.862	1.678	2.325	2.612
4500	1.099	1.603	1.835	1.647	2.294	2.579
5000	1.078	1.581	1.811	1.620	2.266	2.549
5500	1.060	1.561	1.789	1.596	2.241	2.523
6000	1.043	1.543	1.769	1.574	2.219	2.499