ECONOMIC AND BEHAVIORAL FACTORS IN AN INDIVIDUAL'S DECISION TO GET AN INFLUENZA VACCINATION IN JAPAN†

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SUMMARY

This paper investigates how people decide to take influenza vaccination in Japan. Using a large-scale survey, we found that people decide rationally, considering the costs and benefits of vaccination. Specifically, people take into account the probability of infection, severity of the disease, and effectiveness and side effects of vaccination, discounting the future benefits of the vaccination and being affected by risk aversion. In addition, we found that behavioral variables such as altruism and overconfidence are also important. Our survey suggests that dissemination of information on the effectiveness of vaccination may raise the vaccination rate, while information on the probability of infection may have the opposite effect.

JEL Classification Numbers: I19

KEY WORDS: influenza; inoculation; survey; time preference; Japan

1. INTRODUCTION

Influenza can be a serious disease in modern societies. As a serious pandemic, it can cause morbidity and mortality, as happened in 2009 with the swine flu. Since vaccination against flu can potentially prevent this illness, study of the factors that are considered when making a decision to take or not to take the vaccine can help prevent the outbreak of influenza. The objective of the current study is to examine how willingness to take the influenza vaccination depends on economic aspects such as costs and benefits as well as behavioral aspects including perceptions regarding influenza and the vaccination against it, preference parameters, and personal attributes. To achieve this aim, we use the behavioral economic model and results of a large data survey in Japan.

The study takes an economic approach and determines the relationship between vaccine taking and the costs/benefits of vaccination from utility-maximizing behavior. Based on the classic expected utility framework, we assume people compare the benefits and costs of taking the vaccine, and choose to be vaccinated if the benefits exceed the costs. Our model predicts that the decision to be vaccinated depends on the perceived probability of infection, severity of disease, side effects of vaccination, and inoculation costs.

The economic approach has been used to examine individual decisions regarding whether to take the vaccine or not (see for example: Brito *et al*., 1991, Mullahy*,* 1999 Shahrabani *et al*., 2008). The relationship between the decision to take vaccination was calibrated with sensible values in a theoretical framework (Shahrabani *et al*. 2008). Results show that values of objective factors predict a very high vaccination rate, implying that an individual's perceptions and beliefs do not accurately reflect actual values and that behavioral factors may be important in the decision. For example, perceived risks of infection may affect individual's propensities to be immunized (Mullahy, 1999). Thus, psychological factors, in addition to economic variables, should be considered to fully understand the vaccination rate.

The Health Belief Model (HBM) developed by Rosenstock *et al*. (1988) is a traditional psychological approach to explaining and predicting preventive health behavior. HBM has been used to explore a variety of health behaviors, including vaccination (Blue and Valley, 2002; Chen *et al*. 2007; Lau *et al*., 2008; Shahrabani *et al*. 2009; Tsutsui *et al*. 2010). According to the HBM, the acceptance of an influenza vaccine depends on the following predictors: perception of susceptibility to influenza, beliefs about the severity of influenza, perceived benefits of the vaccine in preventing influenza, and perceived barriers to accepting a vaccine (Blue and Valley, 2002; Chapman and Coups, 1999).

The factors that explain vaccination behavior according to utility-maximizing behavior are very similar to those of the HBM. However, our theory predicts that an individual’s time discount and risk aversion also play important roles in the decision to take vaccination or not. We hypothesize that people choose to take a flu vaccination when benefits exceed costs (specified as benchmark equations in section 2.1), but introduce an extended model which takes into account behavioral aspects that may affect the decision to be vaccinated. In particular, we examine whether psychological factors such as altruism, overconfidence, and the status quo effect play an important role in the decision.

We designed questions concerning a respondent’s beliefs regarding influenza and vaccination and their preferences, and conducted a large-scale survey in Japan to test our theoretical prediction. Thus, although we rely on the economic approach, we actually use perception or belief variables as does the HBM, so that our results are immune from the above critique of Shahrabani *et al*. (2008).

The current study contributes to existing literature by: (a) expanding the behavioral economic model to include the impact of altruism on the willingness to be vaccinated; (b) presenting empirical results of the model using a large-scale survey in Japan; (c) applying the results to policy implications regarding dissemination of information on influenza and the vaccination against it; and (d) comparing factors affecting the willingness to be vaccinated among Japanese people to factors affecting the population in the USA as reported in previous studies.

The paper is organized as follows. In section 2, we explain the analytical framework including the basic model and extended model. In subsections 2.1 and 2.2, we develop a model based on rationality while in subsection 2.3, we introduce behavioral variables to the basic model. Section 3 explains the methods and describes the survey in Japan. Section 4 is devoted to the results. Section 5 summarizes the study and concludes by showing how the inoculation rate can be increased.

2. ANALYTICAL FRAMEWORK

2.1. Model

Benefits: The benefits of vaccination are relaxation of (a) one's condition and (b) the degree of inconvenience to one's family and friends when one is infected with flu. These benefits are realized a couple of months after being vaccinated. Thus, the magnitude of the benefits depends on how one perceives (1) the seriousness of the disease, (2) how the vaccination relieves the condition, (3) the probability of infection, (4) the time discount rate, and (5) risk aversion. Time discounting matters because the benefits of vaccination are received in the future, while the costs are paid earlier. Risk aversion involves assessing the risk of contracting flu and the side effects of the vaccination.

We denote the probability of contracting flu as *PROB*, the effectiveness of the vaccination by *EFFECT*, and the damage of contracting flu as *DAMAGE*. Thus, the damage of contracting flu is reduced to $(1-EFFECT)\times DAMAGE$, where *EFFECT* is assumed to take on a value between zero and one.

Costs: The cost of vaccination (*COST*) consists of the fee for inoculation (*FEE*), opportunity and psychological costs of taking vaccination, and perceived side effects of vaccination (*SIDEEFFECT*). We assume people suffer these costs at the time of vaccination.

Decision to be vaccinated: The utility of the individual in our model is defined over consumption in two periods, x_1 and x_2. In period 1, the individual decides whether or not to take the vaccine and, in period 2, the individual may be infected by influenza. Thus, the expected utility in the case of taking vaccination is:

$$u(x_1 - COST) + \theta\left[(1-PROB)\times u(x_2) + PROB\times u(x_2 - (1-EFFECT)\times DAMAGE)\right] \quad (1)$$

while the expected utility of not taking vaccination is:

$$u(x_1) + \theta\left[(1-PROB)\times u(x_2) + PROB\times u(x_2 - DAMAGE)\right] \quad (2)$$

where θ is the discount factor. A person will take vaccination if the value of Equation (1) is larger than the value of Equation (2).

Assuming that $x_1 \approx x_2 >> COST$ and *DAMAGE*, and expanding the utility function to the second order, we find that people take vaccination, if:

$$\begin{aligned}&-COST + \theta PROB\times EFFECT\times DAMAGE\\ &-\frac{1}{2}\alpha\left[COST^2 - \theta\times PROB\times EFFECT\times(2-EFFECT)\times DAMAGE^2\right] > 0\end{aligned} \quad (3)$$

where α stands for the absolute risk aversion, $-\frac{u''}{u'}$. This inequality implies that people are more likely to take vaccination when (a) *PROB*, (b) *EFFECT*, or (c)

DAMAGE is greater, (d) *COST* or (e) time discount rate ($\frac{1}{\theta}-1$) is smaller, or (f) risk aversion (α) is higher (lower, respectively), in the case that the fear of getting the flu is greater (smaller) than the fear of side effects, i.e.. $COST^2 < (>)\ \theta \times PROB \times EFFECT \times (2-EFFECT) \times DAMAGE^2$. Conditions (a) to (d) conform with results of the HBM.

Assuming a linear function, (a) to (f) are described in Equation (4), which is the basic equation for estimating willingness to take vaccination (*WTVACCIN*).

$$\begin{aligned} WTVACCIN_i &= a_0 + a_1 PROB_i + a_2 EFFECT_i + a_3 DAMAGE_i + a_5 COST_i \\ &+ a_6 \theta_i + a_7 \alpha_i + u_i \end{aligned} \tag{4}$$

where the subscript *i* stands for the individual *i*. It is straightforward to prove that $a_1, a_2 > 0$ and $a_3, a_5, a_6 < 0$, and a_7 will be positive when *DAMAGE* dominates *SIDEEFFECT*.

To identify the channels through which risk aversion affects *WTVACCIN*, we adopt cross terms of risk aversion and *COST*, and risk aversion and *DAMAGE*, using the following equation.

$$\begin{aligned} WTVACCIN_i &= a_0 + a_1 PROB_i + a_2 EFFECT_i + a_3 DAMAGE_i + a_5 COST_i + a_6 \theta_i \\ &+ a_8 \alpha_i DAMAGE + a_9 \alpha_i COST_i + u_i \end{aligned} \tag{5}$$

where, it is demonstrated that $a_8 > 0$ and $a_9 < 0$.

2.2. Variables in the basic equation

Willingness to get vaccination: *WTVACCIN* is the respondent's intention to take vaccination within 12 months.

Probability of infection: *PROB* is the respondent's assessment of being infected by flu within 12 months, measured in percent.

Damage of flu: *DAMAGE* is the respondent's assessment of the damage suffered if they contract flu. It consists of two elements: *SEVERITY*, the respondent's assessment of the severity of the disease; and *BOTHER*, the respondent's assessment of the degree to which one's family and friends would be inconvenienced if the respondent would become infected.

Effectiveness of vaccination is denoted as *EFFECT*.

Cost of vaccination: We examine *COST* by the following: (a) respondent's assessment of the seriousness of the side effects caused by a flu shot, *SIDEEFFECT*, (b) monetary cost of the shot, and (c) psychological costs. Variables relating to the monetary cost include the inoculation fee, *FEE*, and per capita income, *INCOME*, used to normalize the *FEE*. Variables associated with the opportunity costs of taking the injection include wage and regional dummies, which include factors such as the cost of transportation to the administering hospital.

Preferences: Preferences include time discount rate, *TDR*, and absolute risk aversion, *ARA*. To determine *TDR*, we ask respondents which they prefer: an earlier receipt with a smaller reward or a later receipt with a larger reward. To determine *ARA*, we ask respondents which option they prefer: lower wage with lower risk or higher wage with higher risk, following the method of Barsky *et al*. (1997).

Using these notations of the variables, our basic Equation (4) is now described as

$$\begin{aligned} WTVACCIN_i &= b_0 + b_1 PROB_i + b_2 EFFECT_i + b_3 SEVERITY_i + b_4 BOTHER \\ &+ b_5 FEE + b_6 SIDEEFFECT + b_7 INCOME_i + b_8 TDR + b_9 ARA_i + u_i \end{aligned} \tag{6}$$

2.3. Extension of the model considering behavioral variables

Our basic model assumes that rational individuals decide whether or not to take vaccination based only on the costs and benefits of vaccination. However, other variables representing behavioral preferences and attributes may also affect the decision. In this subsection, we present an extended model that incorporates behavioral preferences and socio-economic variables into the basic Equation (6).

Our extended model takes into consideration an individual's altruism, overconfidence, anxiety regarding their health, and experiences regarding vaccination and flu, i.e., behavioral preferences that are often disregarded in traditional economics.

Altruism: Those who are more altruistic and caring about others may be more likely to take vaccination because they want to avoid troubling others. If so, the degree of altruism, *ALTRUISM*, has a positive effect on taking vaccination. To examine this, we insert $(b_4 + b_{22} ALTRUISM)BOTHER$ or $b_{11} ALTRUISM + b_4 BOTHER$ instead of $b_4 BOTHER$ in the regression, where b_4 and b_{22} represent concern for family and friends, and b_{11} for the general public. We expect b_4 and $b_{22}>0$. In addition, $b_{11}>0$ if a respondent believes that vaccination will mitigate flu epidemics and improve social welfare.

Overconfidence: Overconfidence may lower a respondent's assessment of *PROB*, *SEVERITY*, *SIDEEFFECT*, or *BOTHER*. However, these variables are already included in the regression. To examine whether or not overconfidence affects vaccination behavior through some other channel not already specified in the regression, we add a variable for overconfidence, *OVERCON*.

Anxiety over health condition: Those who are concerned about their health will tend to take the vaccination. Thus, we take into account three variables: the degree of their health anxiety, *HEALTH*, and whether they undergo blood tests periodically, *TESTP*, or when disease is suspected, *TESTS*.

Psychological costs: Status quo bias means people are reluctant to start new things (Knetsch and Sinden 1984). Accordingly, people who have never been vaccinated may resist taking the vaccination while those who are accustomed to being vaccinated every year may be reluctant to stop being vaccinated. We measure this psychological cost of taking vaccination by the respondent's experience with flu vaccination, *EXVACCIN*. Those who were vaccinated in recent years are more likely to be vaccinated again.

Past experience of catching flu: Past experience of being ill with flu, *EXFLU*, is also expected to influence *WTVACCIN*. Those who suffered seriously will tend to take the vaccination, while those who experienced a mild condition may think that inoculation is unnecessary. Those who suffered seriously should have stronger memory and *EXFLU* is expected to be positive.

Attributes: We include gender, age, marital status, whether or not the respondent has children, and level of education in our extended regression Equation (7):

$$\begin{aligned} WTVACCIN_i &= b_0 + b_1 PROB_i + b_2 EFFECT_i + b_3 SEVERITY_i + b_4 BOTHER_i + b_5 FEE_i \\ &+ b_6 SIDEEFFECT_i + b_7 INCOME_i + b_8 TDR_i\,(HOMEWORK_i) + b_9 ARA_i\,(UMBRELLA_i) \\ &+ b_{10} ALTRUISM_i + b_{11} OVERCON_i + b_{12} HEALTH_i + b_{13} TESTP_i + b_{14} TESTS_i \\ &+ b_{15} EXVACCIN_i + b_{16} EXFLU_i + b_{17} MALE_i + b_{18} AGE_i + b_{19} UNMARRY_i + b_{20} NOCHILD_i \\ &+ b_{21} SCHOOL_i + b_{22} ALTRUISM_i * BOTHER_i + u_i \end{aligned} \tag{7}$$

3. DATA AND THE ESTIMATION METHOD

3.1. Data

Data used in this paper were obtained from a survey conducted by the COE (Center of Excellence) project of Osaka University in February 2005 with 4300 people from throughout Japan randomly selected by the double stratified random sampling method.[1] The selected participants were visited in their homes and given a questionnaire. Several days later, the filled-out questionnaires were picked up from their homes; 2987 questionnaires (70%) were returned. The range, means, and

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[1] The questionnaire (in Japanese) is found at http://www2.econ.osaka-u.ac.jp/coe/project/survey-0502.pdf.

standard deviations of the main variables used for the analysis are presented in Table I.

Place Table I here

3.2. Estimation method

Since willingness to get vaccination, *WTVACCIN*, is an ordered variable from 1 to 5 we estimate Equation (6) by ordered probit.A problem with this estimation is that those who decide to take vaccination usually assess *PROB* lower than those who choose not to be vaccinated. Thus, a reverse causality between *WTVACCIN* and *PROB* exists, making *PROB* an endogenous variable.

This conjecture has some support. *WTVACCIN* among 60-70 year-old respondents is significantly higher than among 20-50 year-olds (Figure 1).[2] In contrast, *PROB* decreases with age, probably because elderly people are more likely to take the flu vaccination than younger people.

Place Figure 1 here

Since all the subjective variables including *WTVACCIN* may be endogenous, we check if results that do not correct the endogeneity biases are robust. We eliminate this endogeneity by regressing each subjective variable over the exogenous variables to estimate a reduced form. For the case of *PROB*, we construct the fitted value, *FITTTED_PROB*, as in regression Equation (8). Using *FITTED_PROB* instead of

[2] The *t* statistic of the difference of means test between over and under-60 groups is 10.2, rejecting the hypothesis of equal means at very low probability. Thus, those over 60 are more willing to be vaccinated than those under 60. Experience of vaccination, *EXVACCIN*, is also higher for over- 60s.

PROB in Equation (7) will correct the endogeneity biases.[3]

$$\begin{aligned} PROB_i &= c_0 + c_7 INCOME_i + c_9 TDR_i\ (HOMEWORK_i) + c_{10} ARA_i (UMBRELLA_i) \\ &+ c_{11} ALTRUISM_i + c_{12} OVERCON_i + c_{13} HEALTH_i + c_{14} TESTP_i + c_{15} TESTS_i \\ &+ c_8 EXVACCIN_i + c_{16} EXFLU_i + c_{17} MALE_i + c_{18} AGE + c_{19} UNMARRY_i \\ &+ c_{20} NOCHILD_i + c_{21} SCHOOL_i + u_i \end{aligned} \quad (8)$$

By the same token, *SEVERITY* and *BOTHER* may be affected by *WTVACCIN*. Thus, we estimate Equation (8) for these two variables and construct the fitted values, *FITTED_SEVERITY* and *FITTED_BOTHER*.

4. RESULTS

4.1. Results of basic Equation (6)

Estimates of basic Equation (6) are presented in the left-hand columns of Table II. Because the dependent variable, *WTVACCIN*, is denoted in integers from 1 to 5, and larger values indicate stronger willingness, we estimate the equation with ordered probit. However, we do not try to correct endogeneity biases here. Pseudo R^2 is around 0.11, high for a cross-sectional regression with a large number of samples. Most of the estimates are significant and show the expected sign, suggesting that basic Equation (6), assuming rational choice, well explains vaccination behavior.

Place Table II here

PROB, EFFECT, SEVERITY, BOTHER, and *SIDEEFFECT* are highly significant, showing a positive sign as expected. *FEE* is not significant, implying that monetary cost is not important in Japan. However, per capita household income has a positive

[3] To identify Equation (8) from Equation (7), Equation (8) excludes some variables that were insignificant in equation (7).

sign and is significant at the 5% level, suggesting that higher income promotes *WTVACCIN*. This may be because the fee is of less importance to households with a higher income.

We do not show the results associated with opportunity costs in this regression in Table II to save space. Thus, the following is a brief report on the effect of opportunity costs. Important opportunity costs include those for transportation and lost revenue. Direct data are not available for transportation costs, so we make do with dummy variables dependant on the size of the respondent's city and region. Lost revenue is defined as the time required to take the vaccination multiplied by the wage rate. In the questionnaire, we ask respondents how many hours they work per week, how many days per year, and how much income they receive for their labor. Thus, *WAGE* is calculated as labor income/(work hours × work days/7). We add *WAGE* and regional and city-size dummies (proxies for lost time) to Equation (6). Although *WAGE* was expected to negatively affect *WTVACCIN*, the estimate is not significant. Likewise, none of the regional and city-size dummies were significant at the 5% level. However, while we found no evidence that opportunity costs significantly affect vaccination behavior, this may not necessarily imply that opportunity costs are unimportant since our data regarding opportunity costs are far from perfect.

TDR, the time discount rate for the immediate future, has a significant negative sign, as predicted in our model, implying that those who heavily discount the expected benefits of vaccination are less likely to take vaccination. Discount rates over a long time horizon such as one year, however, are not significant, implying that time discounting for the immediate future is crucial for *WTVACCIN* (results not shown to save space).

ARA has a significant positive sign, suggesting that fear of contracting flu dominates fear of side effects from the vaccination. Thus, risk aversion promotes taking vaccination.

4.2. Results of extended Equation (7)

Results of the extended model Equation (7), including *ALTRUISM* in the regression, are presented in the middle columns of Table II. The fit of this specification is good. The adjusted R^2 is much improved, compared to the basic Equation (6).[4] The variables included in basic Equation (6) are almost the same.

ALTRUISM is significant at the 0.1% level and *HEALTH* has a significant positive sign, as expected. However, *TESTP* and *TESTS* are insignificant, even though they have positive signs. *OVERCON* is insignificant, suggesting it does not affect vaccination behavior through channels other than those specified in the regression, such as *PROB*.

EXVACCIN is highly significant, indicating that having been vaccinated in the past reduces the psychological costs of taking vaccination. The large coefficient suggests that psychological costs are weighty in deciding to be vaccinated, supporting the 'status quo bias' hypothesis that human beings are reluctant to change. *EXFLU* is positive but insignificant, suggesting that painful memories of previous experiences with flu dominate relatively pleasant memories, but only slightly.

Among attributes, females, the elderly, the unmarried, and those who have children are more likely to take vaccination. Schooling does not affect vaccination behavior.

When *ALTRUISM*BOTHER* replaces *ALTRUISM* in the equation (right columns of Table II), the cross term is highly significant with a positive sign, implying that

[4] This is partly due to the inclusion of experience of vaccination, *EXVACCIN*.

those who are altruistic tend to take vaccination to avoid troubling their families.[5]

4.3. Examination of time discount rate (*TDR*) and risk aversion (*ARA*)

While the total number of responses to the survey was 2987, only 1849 observations were available for estimating Equation (6), partly because many respondents did not answer questions on *TDR* and *ARA*.[6] Thus, to check the robustness of the results, we present the results using qualitative data associated with *TDR* and *ARA* in the left columns of Table III. There, *HOMEWORK* is data relating to when the respondent did homework in childhood (those who made it a rule to do homework early in the school holiday are regarded as more patient) and *UMBRELLA* is determined by asking how high the probability of rain has to be to take an umbrella (those who report that a low probability is sufficient are regarded as more risk averse). In this case, 2173 observations are available. *UMBRELLA* is positive and significant at the 0.1% level, and *HOMEWORK* is negative and significant at the 5% level, confirming the results for *TDR* and *ARA*. Other variables are almost unchanged from those presented in the left columns of Table II, indicating that our results are robust for the sample size.[7]

Place Table III here

In the middle and right columns of Table III we show the estimation results of Equation (5), which examines two channels through which risk aversion impacts *WTVACCIN*. When cross terms for risk aversion and severity (representing

[5] However, neither is significant, when both terms are included at the same time.

[6] The number of observations was also limited by the fact that many respondents did not answer the question regarding income.

[7] However, estimates of the coefficients of variables associated with the cost of vaccination changed from those in Table II. This is because the psychological cost, *EXVACCIN*, is not included in basic Equation (6). When *EXVACCIN* is included, the coefficients of *SIDEEFFECT*, *INCOME*, and *FEE* are almost unchanged.

DAMAGE), *ARA*SEVERITY*, and risk aversion and side-effect (representing *COST*), *ARA*SIDEEFFECT*, are used, the coefficient of the former, i.e. a_8 in equation (5), is positive and significant at the 1% level, and that of the latter, i.e. a_9 in equation (5), is negative and significant at the 5% level. This result supports our hypothesis that risk aversion operates through the fear of getting the flu, which is stronger than the fear of side effects of the vaccination. When a cross term for risk aversion, severity, and effect, *ARA*SEVERITY*EFFECT*, is used instead of *ARA*SEVERITY*, the results are unchanged.[8] This result is consistent with the result that risk aversion, in general, negatively affects *WTVACCIN*.

4.4. Perception variables

Estimation of the auxiliary Equation (8) reveals that *OVERCON* negatively affects *PROB* at the 10% significance level, *SEVERITY* at the 0.1% level, and *BOTHER* at the 10% level. The dummy variable for male, *MALE*, has the same signs as those of *OVERCON* in all the estimations.[9] As expected, *HEALTH* positively affects *PROB*, *SEVERITY*, and *BOTHER*. A dummy variable for having no children, *NOCHILD*, understandably has a negative coefficient in the *BOTHER* equation. *AGE* is highly significant with a negative sign in *PROB* and *BOTHER* equations. *SCHOOL* is significantly negative for *SEVERITY* and positive for *BOTHER*, but insignificant for *PROB.*

4.5. Results of Equation (7) using fitted values

To correct for possible endogeneity biases, we estimate Equation (7) using fitted

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[8] See footnote 7.

[9] Barber and Odean (2001) argue that males are more overconfident than females and use a male dummy as a proxy of overconfidence.

values of *PROB*, *SEVERITY*, and *BOTHER* (Table IV).[10] The fitted values are used one by one because they are highly correlated (the correlation coefficient is around 0.5), which seems to cause multicolinear problems when all three are used at the same time.

Place Table IV here

When *PROB* is substituted by *FITTED_PROB*, most of the estimates are unchanged from those in Table II, suggesting causality of subjective probability of infection to willingness to vaccination. *FITTED_SEVERITY* is significantly positive and most estimates are similar to those in Table II, suggesting that *SEVERITY* also causes *WTVACCIN*. *FITTED_BOTHER*, however, is insignificant, casting doubt that *BOTHER* really affects *WTVACCIN*. The causality may be reverse, and it may be that those who plan to take vaccination believe that they will less bother their family.

5. DISCUSSION AND CONCLUSION

This paper develops an economic model to explain the mechanism by which people in Japan decide whether or not to take influenza vaccination. Using our model and data obtained from our large-scale survey conducted in Japan, we demonstrate that people rationally make the decision considering the costs and benefits of vaccination. People take into account the probability of infection, severity of the disease, and effectiveness, side effects, and future benefits of the vaccination. Risk aversion also affects the decision through the fear of contracting the flu and the fear of side effects of the vaccination. However, we found no evidence that monetary cost is important in

[10] *OVERCON* and *EXFLU*, which are insignificant in the middle column of Table II, are excluded in this regression.

making the decision. The results of this Japanese sample are compatible with the findings of Tsutsui *et al*. (2010) with respect to their USA sample.

Yet, people also deviate from rationality. Altruism, a behavioral variable, plays an important role in making the decision. To the best of our knowledge, the effect of altruism on the willingness to be vaccinated has not yet been examined. Status quo bias is clearly recognized, in that people who have never been vaccinated tend to avoid taking vaccination. Overconfidence affects the decision indirectly via perception variables such as the subjective probability of infection and assessment of the severity of influenza, similar to findings in the USA sample (Tsutsui *et al*. 2010). The decision also depends on attributes such as gender, age, and marital status.

The results of this paper have interesting implications. First, raising the inoculation rate is often thought to be socially desirable because taking vaccination has strong externality. However, we found that the degree of altruism affects the willingness to take vaccination not only through the channel of concern for one's family and friends, but also through a channel of caring about a wider range of people. Therefore, if most Japanese are altruistic, the vaccination rate will not differ substantially from the social optimum. However, our survey indicates that 44% of Japanese respondents show no altruism, suggesting that it is desirable for the society to raise the vaccination rate to a level higher than the rate that people choose spontaneously.[11]

If the general perception of flu and vaccination is inaccurate, supplying accurate information on the illness, its possible complications, and the effectiveness of the vaccination will probably raise or lower the vaccination rate. Thus, we examine whether the general perception is biased. *WTVACCIN* depends on six perceptions:

[11] In the US only 24% are not altruistic.

PROB, *SEVERITY*, *BOTHER*, *EFFECT*, *SIDEEFFECT*, and *FEE*. The mean *PROB* is 24%. Although there are no statistics on the total number of flu cases in Japan, based on the 1.56 million infections reported in 2005 from 4700 hospitals, the probability of infection is only 1.5%. This number, of course, terribly underestimates the true rate and more reliable information can be derived from our survey. Some 10.5% of our respondents indicated that they were infected with flu during the previous two years, reflecting a yearly probability of infection of about 5%. Since this rate is still lower than the subjective probability to be infected (24%), providing information on the probability of contracting flu would probably reduce the vaccination rate.

Most of the other perception variables are qualitative and not easy to compare with actual figures. However, they do not seem to radically contradict the facts. For example, while 60% of the respondents answered 'the shot can prevent certain types of flu', 20% selected 'despite the flu shot, a high possibility to get the flu remains,' which contradicts the truth and underestimates the effectiveness of vaccination. For *FEE*, 55% chose 'the fee is 2000-5000 yen,' and for *SEVERITY*, 60% chose 'a disease which takes about a week from which to recover', both of which are correct. Although 50% accurately answered that 'side effects have little influence', about 10% selected "very serious side effects that could cause after effects" and 5% selected "extremely serious side effects that could cause death," which overestimate potential side effects of flu vaccination.

From these results, we make three conclusions. First, Japanese people generally have correct information. Second, they evaluate the effectiveness of vaccination as too low and the side effects as too high, so that dissemination of information on the effectiveness of vaccination may help raise the vaccination rate. Third, they evaluate the probability of the getting flu as too high, suggesting that provision of correct information on the probability of infection may mitigate the willingness to vaccinate. The second and the third conclusions are the same as those of Tsutsui *et al.* (2010) with respect to the USA, which are derived by an econometric analysis.

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Table I. Definitions and mean values of variables in the study

Variable	Definition	Range Min	Range Max	Mean	Std error
WTVACCIN	Willingness to be vaccinated	1	5	2.712	0.029
PROB	Subject assessment of probability of getting flu (%)	0	100	23.868	0.469
SEVERITY	Self-assessment of seriousness of flu	1	6	3.260	0.026
BOTHER	Degree of bothering one's family and friends if infected	1	4	2.874	0.018
EFFECT	Effectiveness of vaccination	1	5	2.950	0.016
SIDEEFFECT	Seriousness of side effects of vaccination	1	7	3.055	0.039
FEE	Fee for inoculation	1	6	4.539	0.021
INCOME	Annual income per family member (ten thousand yen)	8.333	1500	222.807	3.632
TDR	Time discount rate	-0.562	26.890	7.904	0.272
ARA	Absolute risk aversion	0.000	0.444	0.036	0.001
OVERCON	Degree of overconfidence	1	5	2.784	0.022
HEALTH	Anxiety regarding health	1	5	3.223	0.025
ALTRUISM	Degree of altruism	0	1	0.551	0.012
EXVACCIN	Experience of flu vaccination	0	1	0.521	0.012
EXFLU	Experience of contracting flu	0	1	0.113	0.008
TESTP	Had a periodic blood test in the last 12 months	0	1	0.652	0.011
TESTS	Had a blood test because of suspected disease in the last 12 months	0	1	0.096	0.007
DMAN	A dummy variable where male = 1, female = 0	0	1	0.492	0.012
AGE	Age of respondent	22	72	49.215	0.302
UNMARRY	A dummy variable where unmarried = 1, otherwise = 0	0	1	0.128	0.008
NOCHILD	A dummy variable where no children = 1, otherwise = 0	0	1	0.192	0.009
SCHOOL	Level of education where 1 = lowest to 11 = highest	1	11	4.081	0.048

Table II. Results of basic Equation (6) and extended regression Equation (7) for estimating vaccination behavior, *WTVACCIN*

		Equation (6)		Equation (7) using *ALTRUISM*		Equation (7) using *ALTRUISM *BOTHER*	
Variable		Estimate	*p*-value	Estimate	*p*-value	Estimate	*p*-value
CONSTANT		-0.978	0.000	-2.445	0.000	-2.34	0.000
PROB		0.008	0.000	0.008	0.000	0.008	0.000
DAMAGE	*SEVERITY*	0.134	0.000	0.111	0.000	0.112	0.000
	BOTHER	0.236	0.000	0.26	0.000	0.22	0.000
EFFECT		0.251	0.000	0.228	0.000	0.227	0.001
COST	*SIDEEFFECT*	-0.046	0.004	-0.057	0.001	-0.057	0.204
	FEE	0.015	0.594	0.038	0.202	0.038	0.045
	INCOME	0.0004	0.030	0.0004	0.051	0.0004	0.027
TDR		-0.005	0.019	-0.005	0.029	-0.005	0.038
ARA		1.1	0.014	1.033	0.038	1.034	0.852
Behavioral variables	*OVERCON*	-	-	0.004	0.893	0.005	0.027
	HEALTH	-	-	0.057	0.026	0.057	0.000
	ALTRUISM	-	-	0.217	0.000	-	-
	ALTRUISM BOTHER*	-	-	-	-	0.076	0.000
	EXVACCIN	-	-	0.877	0.000	0.878	0.156
	EXFLU	-	-	0.116	0.164	0.118	0.108
	TESTP	-	-	0.099	0.111	0.1	0.250
	TESTS	-	-	0.116	0.248	0.115	0.004
	MALE	-	-	-0.153	0.004	-0.154	0.000
	AGE	-	-	0.018	0.000	0.018	0.082
	UNMARRY	-	-	0.217	0.085	0.219	0.006
	NOCHILD	-	-	-0.292	0.006	-0.293	0.384
	SCHOOL	-	-	-0.012	0.374	-0.012	0.000
Boundary values	μ_3	1.069	0.000	1.174	0.000	1.174	0.000
	μ_4	1.747	0.000	1.964	0.000	1.964	0.000
	μ_5	2.347	0.000	2.686	0.000	2.688	0.000
Pseudo R^2		0.111		0.291		0.292	
Number of observations		1849		1752		1752	

The first column contains the variables that determine *WTVACCIN*. When the variable in the first column consists of multiple variables, those are shown in the second column. The estimation method is ordered probit.

Table III. Examination of time discounting and risk aversion

		Equation (6) using *HOMEWORK* and *UMBRELLA*		Equation (5) using *ARA*SEVERITY* and *ARA*SIDEEFFFECT*		Equation (5) using *ARA*EFFECT*SEVERITY*	
Variable		Estimate	p-value	Estimate	p-value	Estimate	p-value
CONSTANT		-0.863	0.000	-0.912	0.000	-0.834	0.000
PROB		0.007	0.000	0.008	0.000	0.008	0.000
DAMAGE	*SEVERITY*	0.13	0.000	0.105	0.000	0.11	0.000
	BOTHER	0.229	0.000	0.235	0.000	0.234	0.000
EFFECT		0.254	0.000	0.249	0.000	0.222	0.000
COST	*SIDEEFFECT*	-0.0002	0.993	0.015	0.588	0.016	0.570
	FEE	0.0002	0.249	0.0003	0.058	0.0003	0.059
	INCOME	-0.045	0.003	-0.025	0.191	-0.029	0.107
Time discount	*TDR*	-	-	-0.005	0.016	-0.005	0.016
	HOMEWORK	-0.035	0.045	-	-	-	-
Risk aversion	*ARA*	-	-	-	-	-	-
	UMBRELLA	0.004	0.001	-	-	-	-
	*ARA*SEVERITY*	-	-	0.77	0.003	-	-
	*ARA*EFFECT*SEVERITY*	-	-	-	-	0.219	0.003
	*ARA*SIDEEFFFECT*	-	-	-0.605	0.028	-0.46	0.050
Boundary value	μ_3	1.069	0.000	1.07	0.000	1.07	0.000
	μ_4	1.748	0.000	1.748	0.000	1.748	0.000
	μ_5	2.33	0.000	2.349	0.000	2.349	0.000
Pseudo R^2		0.109	-	0.113	-	0.113	-
Number of observations		2173	-	1849	-	1849	-

The first column indicates the variables that determine *WTVACCIN*. When the variable in the first column consists of multiple variables, those are shown in the second column. The estimation method is ordered probit.

Table IV. Results of extended regression Equation (7) for estimating vaccination behavior, *WTVACCIN* using fitted values from auxiliary Equation (8)

	FITTED_PROB		*FITTED_SEVERITY*		*FITTED_BOTHER*	
Parameter	Estimate	P-value	Estimate	P-value	Estimate	P-value
Constant	-2.792	0.000	-2.786	0.001	-0.682	0.800
FITTED_PROB	0.016	0.007	.	.	.	.
PROB	.	.	0.009	0.000	0.009	0.000
FITTED_SEVERITY	.	.	0.145	0.000	.	.
SEVERITY	0.115	0.000	.	.	0.151	0.000
FITTED_BOTHER	.	.	.	.	-0.331	0.671
BOTHER	0.269	0.000	0.294	0.592	.	.
EFFECT	0.216	0.000	0.236	0.000	0.238	0.000
SIDEEFFECT	-0.049	0.003	-0.039	0.000	-0.048	0.004
FEE	0.048	0.110	0.049	0.015	0.057	0.058
INCOME	0.0004	0.032	0.0004	0.101	0.0002	0.479
TDR	-0.005	0.040	-0.005	0.064	-0.005	0.025
ARA	0.947	0.058	1.041	0.033	0.795	0.158
HEALTH	0.043	0.113	0.049	0.037	0.086	0.107
ALTRUISM	0.213	0.000	0.212	0.212	0.218	0.000
EXVACCIN	0.863	0.000	0.865	0.000	0.886	0.000
TESTP	0.094	0.130	0.100	0.000	0.110	0.083
TESTS	0.110	0.269	0.113	0.136	0.230	0.197
MALE	-0.128	0.018	-0.134	0.277	-0.208	0.056
AGE	0.020	0.000	0.018	0.068	0.010	0.306
UNMARRY	0.263	0.044	0.231	0.000	0.083	0.716
NOCHILD	-0.286	0.007	-0.290	0.070	-0.396	0.023
SCHOOL	-0.012	0.395	-0.012	0.017	-0.010	0.494
μ_3	1.157	0.000	1.165	0.454	1.159	0.000
μ_4	1.935	0.000	1.950	0.000	1.937	0.000
μ_5	2.652	0.000	2.669	0.000	2.642	0.000
Pseudo R^2	0.274	-	0.282	0.000	0.268	-
Number of observations	1752	-	1752	-	1752	-

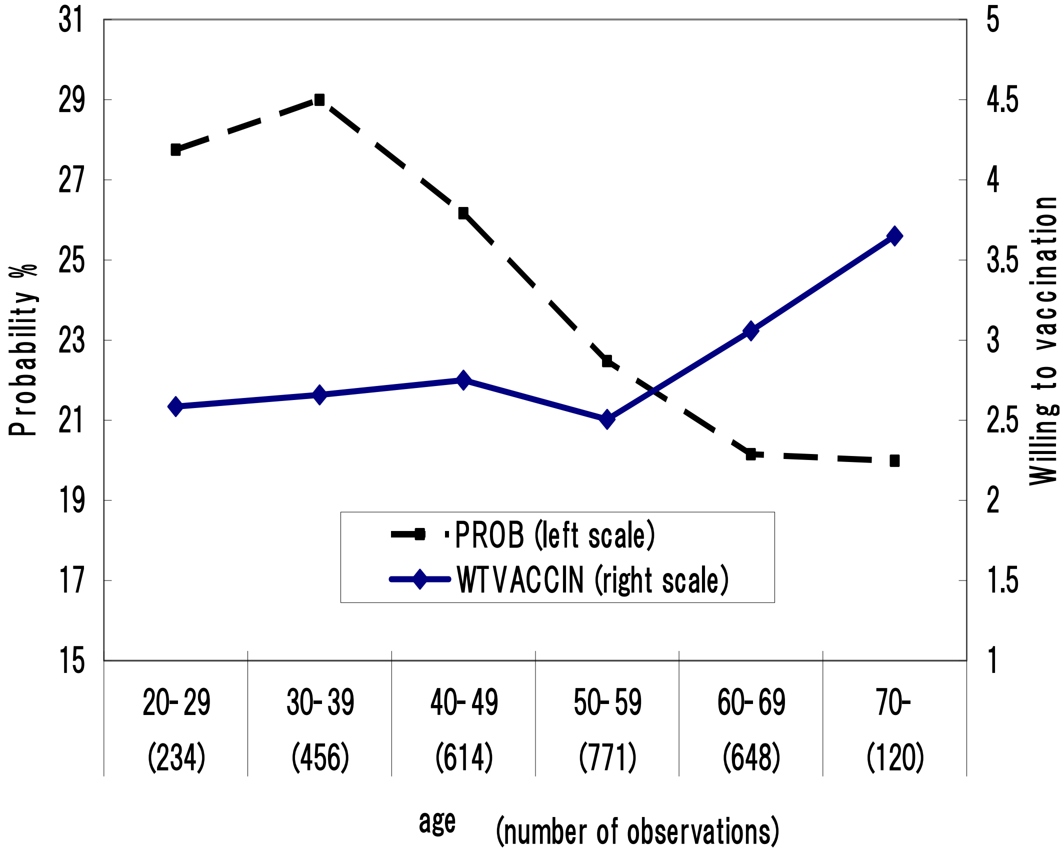

Figure 1. Willingness to take vaccination (*WTVACCN*) and assessment of the probability of contracting flu (*PROB*) by age