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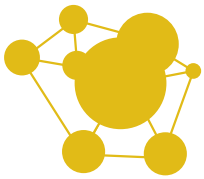

ExpSS21

Working Paper

ExpSS-E-8

Consumer reaction to information on food additives: Evidence from an eating experiment and a field survey

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July, 2008

Grant-in-Aid for Scientific Research on Priority Areas

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Abstract

Both presence/absence of food additive and provision of accurate information about food additive are considered as important factors affecting individuals' purchase decisions. In this paper, we apply both laboratory experiment and field survey approaches to investigate how individuals value a kind of food additive (i.e. sodium nitrite) presented in ham sandwich and whether the provision of information about sodium nitrite affects individuals' choice. The results suggest that in both laboratory experiment and field survey samples, participants do not favor the use of sodium nitrite *per se*, no matter whether the detailed information is provided or not. Moreover, the willingness to pay values for ham sandwich without sodium nitrite are estimated to be lower in the experiment sample and higher in the survey sample after a set of negative and positive information is provided, implying that the effect of information provision differs between these two methods. In addition, further investigation of the participants' reasons choosing ham sandwich indicates that the information related to flavor seems influence more on their choice behavior in the experiment sample, while the information associated with health risk is like to play a relatively more important role in the survey sample. Finally, we also find that a number of socioeconomic characteristics affect the participants' choice in ham sandwich in the survey sample.

Key words: laboratory experiment, field survey, information, sodium nitrite, ham sandwich

JEL classification: C91; C93; Q18

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1. Introduction

In recent years, particularly after the worldwide spread of Bovine Spongiform Encephalopathy (BSE), consumers are becoming increasingly cautious about food safety. The number of reported foodborne illnesses has been on the rise in Japan. However, in spite of provisions of scientific evidence, whether or not these foodborne outbreaks are attributable to food additives is still debatable. Both favorable and unfavorable information about food additives are made available to consumers. Therefore, it is difficult for them to select the most trustworthy information when choosing between food products that contain and do not contain additives. In view of this situation, researches on how consumers evaluate food safety and what kind of information turn to be extremely important to both policy decision makers and food producers.

Although few in number, the previous studies on this issue have made great contributions to the literature (e.g., Burton et al., 2001; Fox et al., 2002; Hayes et al., 2002; Marette et al., 2007; Prescott and Young, 2002; Tonsor and Schroeder, 2003; Matsumoto, 2004; Shogren et al., 1994). Fox et al. (2002) and Hayes et al. (2002) investigate how contradictory information about food irradiation (i.e., negative and positive information) affects consumers' willingness to pay (WTP) for controlling *Trichinella* in irradiated pork. Negative information indicates the possibility of food irradiation being linked to cancer and birth defects, while positive information indicates that food irradiation is a process that destroys harmful bacteria and pathogens from food to prevent foodborne illness. Both of these studies find that positive information increases WTP, whereas negative information decreases it. However, when both positive and negative information were provided simultaneously, the results show that the negative information clearly dominates. The most remarkable point of their studies is that they created a real situation through an experiment wherein subjects were asked to eat a ham sandwich while confronting two types of risk (i.e., developing cancer or being afflicted with a foodborne illness). The study of Marette et al. (2007) reports similar results as the above two studies. They elicit consumers' WTP for fish, which poses both health risks (methylmercury) and benefits (omega-3 fatty acids) to the consumer. In their study, the subjects were asked to taste two types of fish before the experiment. The results reveal that information about risks had a larger marginal impact on the change in WTP than the information about benefits did. In addition, Shogren et al. (1994) elicited consumer WTP for and willingness to accept (WTA) two private market goods (i.e., candy bars and coffee mugs) and a private non-market good (i.e., reduction of human health risks) and test their divergence. They discovered that the divergence of WTP and WTA for market goods disappears with repeated exposure to the market. In contrast, for the non-market good with no close substitute, the divergence is robust and persistent even with repeated market participation and full information disclosure on the characteristics of the good.

We modified the previous literatures' experimental designs (i.e., Fox et al., 2004; Hayes et al., 2004; Shogren et al., 1994) by applying the choice experiment approach because consumers usually buy foods with posted prices. The significant merits of the choice experiment approach are that the translation of commodities' features into attributes enables analysts to assess the impact of change in the objective properties of commodities and to a great extent, overcome possible biases such as strategic bias, compliance bias, and warm glow bias usually found in contingent valuation (CV) studies.[1] Many studies that elicit consumers' WTP with respect to food safety apply the choice experiment method (e.g., Alfnes et al., 2006; Burton et al., 2001; Matsumoto, 2004; Loureiro and Umberger, 2007; Lusk and Schroeder, 2004). Although this approach has been used in field surveys for a long period, it has only recently been applied in the environment of a laboratory experiment (e.g., Lusk and Schroeder, 2004; Alfnes et al., 2006); as a result, it has been documented that although field survey methods have contributed to many areas of inquiry, researchers may encounter a so-called hypothetical bias by applying only these methods. However, evidence of the hypothetical bias appears to be mixed. Kruse and Thompson (2003) employed a survey question and an economics experiment to elicit the value of a risk mitigation investment and reported that the two procedures generate close aggregate measures, but inconsistent individual decisions. Lusk and Schroeder (2004) compared hypothetical (i.e., a field survey) and non-hypothetical (i.e., a laboratory experiment) responses to choice experiment questions on beef ribeye steaks and revealed that although hypothetical choices overestimate the total WTP for beef steaks, the marginal WTP for a change in the quality of steak is generally not statistically different across hypothetical and actual payment settings. In addition, List and Gallet (2001) statistically addressed the issue of hypothetical bias using a meta-analysis of 29 experimental studies. Their empirical findings suggested that on average, subjects overstate their preferences by a factor of about 3 in hypothetical settings and that the degree of over-revelation is influenced by the distinction between WTP and WTA, public versus private goods, and several elicitation methods.

The present study applies both the laboratory experiment and field survey approaches to investigate how individuals value a food additive (i.e., sodium nitrite) presented in a ham sandwich and whether the provision of information about sodium nitrite affects an individual's choice. In the non-hypothetical situation (i.e., a laboratory experiment), we created a more real situation than the previous studies did, not only by providing real economic incentives to the subjects but also by asking them to eat the ham sandwich they choose to purchase. Eating behavior is extremely important when examining food choice behavior, because we believe that offering only monetary incentives to the participants on purchases is insufficient to eliminate the subjects' potential incentive to choose lower priced food.

[1] For more details on this issue, see Louviere et al. (2000).

To investigate the issue of whether or not the provision of information on food affects an individual's choice, we simultaneously provided both negative and positive information about sodium nitrite (i.e., chemical formula $NaNO_2$) in the study. The two main reasons for which we focus on sodium nitrite are as follows. First, contradictory information exists about its benefits and health risks. On the one hand, sodium nitrite helps prevent foodborne botulism (i.e., *Clostridium Botulinum*)[2] and enhances the flavor of meat products. On the other hand, several scientific studies indicate that the use of sodium nitrite possibly leads to cancer. Second, the demand for foods containing sodium nitrite (e.g., ham) has recently increased in Japan. However, a small section of consumers have begun demanding additive-free ham (i.e., ham that does not contain sodium nitrite) probably due to an increased consciousness of food safety. As a result, since 2000, some leading Japanese companies have begun producing additive-free ham. However, currently in Japan, the type of information that consumers consider to be more important is still unclear to both the food policy decision makers and food producers.

As a preview of the results, we first observe that, in both the laboratory experiment and the field survey samples, the participants do not favor the use of sodium nitrite *per se*, irrespective of whether or not detailed information is provided. Second, WTP values for ham sandwiches that do not contain sodium nitrite are estimated to be lower in the experiment sample and higher in the survey sample after a set of negative and positive information is provided, which implies that the effect of information provision differs for the non-hypothetical and hypothetical situations. Third, further investigation of the participants' reasons for choosing a particular ham sandwich indicates that information about flavor has a greater influence on their choice behavior in the experiment sample, while information about health risks is likely to play a relatively more important role in the survey sample. Finally, we also observe that a number of socioeconomic characteristics affect the participants' choice of ham sandwiches in the survey sample.

The remainder of the paper is organized as follows. Section 2 explains the designs of the experiment and the survey. Section 3 describes the empirical model structure. Section 4 presents the results, and Section 5 proffers the conclusions.

2. Designs of the laboratory experiment and field survey

2.1. Procedure of the experiment and survey

We conducted a laboratory experiment and a field survey based on the choice experiment method. Let us first explain the design of the laboratory experiment. As shown in Table 1, the alternatives in the designated choice sets were ham sandwich A, which did not contain sodium nitrite,

[2] *Clostridium Botulinum*, which is prevented by sodium nitrite, is a highly toxic bacterium. In recent times, the number of deaths due to *Clostridium Botulinum* in Japan has been quite small. However, a couple of people die from it every year in other countries (e.g., the United States and Canada).

and ham sandwich B, which contained it. The two types of ham sandwiches were priced at 50 JPY and 80 JPY respectively.[3] The total number of rounds in one session was six. The experimental procedure in rounds 1 to 3 was almost the same as that in rounds 4 to 6, except that (i) information describing sodium nitrite was provided at the beginning of round 4 (i.e., post-information situation), but not in the first 3 rounds (i.e., pre-information situation), and (ii) the subjects were asked to select the two most important reasons that determined their choices from among the alternatives provided. The detailed procedure of the experiment is as follows:

Step 1 One of the experimenters read a consent form aloud at the beginning of the experiment. The consent form stated that subjects would have to eat ham sandwiches six times and that they had the right to drop out of the experiment at any time if they did not wish to eat the ham.[4]

Step 2 An experimenter explained the experimental procedure to the subjects after the experimental instruction sheets were distributed.[5]

Step 3 At the beginning of round 1, the subjects hypothetically received 200 JPY to buy a ham sandwich. Then, they were asked to choose one of the two ham sandwiches that were kept in front of them and eat it. The subjects were told that the amount equal to the price of the selected ham sandwich would be deducted from the 200 JPY that they had hypothetically received.

Step 4 Step 3 was repeated for 2 additional rounds (i.e., rounds 2 and 3).

Step 5 After the first three rounds, the subjects were asked to complete a first questionnaire regarding their knowledge of sodium nitrite and the reasons for their choices in the first three rounds.

Step 6 An information sheet describing sodium nitrite was distributed to the subjects and was read aloud by an experimenter.

Step 7 In round 4, the same procedure as that employed in round 1 was repeated. However, unlike in round 1, the subjects were asked to select two important reasons that determined their choices after they made their decisions.

Step 8 Step 7 was repeated for 2 additional rounds (i.e., rounds 5 and 6).

Step 9 After round 6, the subjects were asked to complete a second questionnaire regarding their socioeconomic characteristics.

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[3] We generated a design consisting of $2^2 = 4$ choice sets with respect to two price levels for two alternatives (i.e., (price of ham sandwich A, price of ham sandwich B) = (50, 50), (50, 80), (80, 50), (80, 80)). However, since there was no price difference between the sets (50, 50) and (80, 80), we removed the set (80, 80). Note that the reason for retaining (50, 50) but not (80, 80) was based on the participants' intake of ham sandwiches during the experiment.

[4] A consent form was provided to every subject during recruitment. They were asked to read it carefully before participating in the experiment. All of the subjects signed the form and no one dropped out during the experiment.

[5] The experimental instructions are provided in Appendix A.

Step 10 The subjects received the sum of a show-up fee (1,000 JPY) and their earnings in cash. The earnings were calculated as the amount received to buy the ham sandwich (200 JPY) minus the price of the ham sandwich (50 JPY or 80 JPY) in each round.

The design and procedure of the field survey were quite similar to those of the laboratory experiment except that (i) the participants were asked to choose (neither buy nor eat) one of the two ham sandwiches by looking at pictures of the sandwiches during the survey; (ii) the respondents listened to the information about sodium nitrite via an MP3 player; and (iii) rather than a monetary incentive, the respondents received a 165 ml bottle of juice in return.

Table 1 is around here

2.2. Information about sodium nitrite

The information about sodium nitrite used in the experiment and the survey is summarized as follows:

Information 1-1:

Sodium nitrite inhibits and delays the growth of anaerobic bacteria such as a Gram-negative bacterium or *Clostridium Botulinum*. The symptoms of foodborne illness caused by *Clostridium Botulinum* include nausea, vomiting, muscle weakness, and nervous symptoms (e.g., double vision, blurred vision, slurred speech, and difficulty breathing), and the case-fatality rate of the illness is more than 20%.

Information 1-2:

Sodium nitrite inhibits and delays the growth of anaerobic bacteria such as a Gram-negative bacterium or *Clostridium Botulinum*. However, the number of patients suffering from a foodborne illness caused by *Clostridium Botulinum* was 1 in 1996, 4 in 1997, 18 in 1998, and 3 in 1999. No deaths were reported during these years. In addition, from 2000 to 2005, no cases of foodborne illness caused by *Clostridium Botulinum* were reported.

Information 2:

Sodium nitrite eliminates the smell of pork, which is the raw material of ham and sausages. Therefore, it plays a significant role in the creation of the distinctive flavor of meat products, which is called “curing flavor.”

Information 3:

It is argued that the formation of nitrosamine by the reaction of sodium nitrite with amino acids in the stomach may be linked to carcinogenesis. However, the residual volume of sodium nitrite in the food products sold in the current market is only a small amount, i.e., 1/5 to 1/14 of 70 ppm as prescribed by the Food Sanitation Law. It is not yet confirmed that using such a small amount of sodium nitrite would create the risk mentioned above.

Information 4:

Since Carcinogenic N-nitrosamines are formed by the combination of sodium nitrite and low amine, which is abundant in fish, it is desirable to limit the use of food additives as much as possible.

Information 1-1, 1-2, and 2 describe the benefits of using sodium nitrite. Information 1-1 is regarded as positive information because it suggests that the health risk posed by *Clostridium Botulinum* can be controlled with the use of sodium nitrite. Information 1-2 is considered to be weakly positive information because the number of patients afflicted with a foodborne illness caused by *Clostridium Botulinum* is rather inconsequential as compared to the Japanese population of 120 million people. Information 2 is also considered to be positive information because consumers are normally satisfied with good flavor. Note that this information about flavor was not considered in most previous studies (e.g., Fox et al., 2004; Hayes et al., 2004, etc.). This study takes this into consideration since the information about flavor has in part proved to be important with respect to food choice (Pliner and Mann, 2004). In addition, Information 3 could be considered as weakly negative because it suggests the possibility that sodium nitrite causes cancer; however, the risk has not yet been confirmed. Information 4 could be regarded as negative information because it warns against the use of sodium nitrite.[6]

Positive and negative information were simultaneously provided at the beginning of round 4. The reason that they were provided simultaneously and not separately is due to the consideration that in the process of purchasing food, consumers are often presented with both positive and negative information with respect to the product they want to buy. Thus, they determine what to do (i.e., to buy or not to buy) based on the type of information they give more weightage. In other words, besides the real purchase and eating behavior in the experiment, we attempted to create a situation concerning information provision that was similar to what consumers actually face.

[6] The descriptions of information 1-1, 1-2, 2, 3, and 4 are based on the Food Safety Commission in Japan (http://www.fsc.go.jp/jinkai/i-dai58-siryou3.pdf); the Ministry of Health, Labor and Wealth in Japan (http://www.mhlw.go.jp/topics/syokechu/index.html); Marudai Food Corporation in Japan (http://www.marudai.jp/corporate/qa.html); Japan Canners Association (http://www.jcs-can.or.jp/qanda/qa_q39.html); and Japanese Consumers' Co-operation Union (http://www.lala.coop/anzen/shouhintest.html), respectively.

2.3. Products

Our use of ham sandwiches was based on the following considerations. First, both the types of ham (with and without sodium nitrite) are sold in most supermarkets in Japan. Therefore, the participants ought to be familiar with these products. Second, there exist controversial discussions on sodium nitrite, which is closely linked to one of our purposes (i.e., which type of information affects consumers' food purchase decision). Third, unlike sausages, ham is often eaten raw. This may lead to a higher possibility of the participants giving the information provided more consideration. The ham used in the experiment was prepared by a Japanese food corporation, and the ham sandwiches were processed by the Co-operative Union in Osaka University for experimental purposes. The size of each ham sandwich was approximately 3 cm × 3 cm, and each ham slice was approximately 9 cm in diameter. We used half of each slice of ham for each ham sandwich to ensure that the subjects' intake would not make them feel full, as they had to eat six times.

2.4. Samples in the laboratory experiment and field survey

We conducted the laboratory experiment at Osaka University. The subjects were recruited through advertisements on campus and from e-mail lists of students who had expressed interest in participating in other experiments. We conducted 9 sessions with 117 subjects from March to June, 2007. Each subject was only allowed to participate in one experimental session. The subjects earned 1,887 JPY on average, and each session lasted for approximately 70 minutes. However, we conducted the field survey in four areas (northern, southern, eastern, and central areas) of Osaka Prefecture from March to April, 2007. In each area, the participants were recruited at stations where people often pass by (i.e., Toyonaka station of Hankyu railway and Senrichuo station of Osaka monorail in the northern area, Sakaihigashi station of Nankai railway in the southern area, Huse and Kawachikosaka stations of Kintetsu railway in the eastern area, and Mikuni station of Hankyu-railway in the central area). In total, we recruited 445 participants. The socioeconomic characteristics of the participants in the experiment and survey are summarized in Appendix B.

3. Model structure

Random utility theory is central to the concept of choice modeling. The basic assumption embodied in the random utility approach to choice modeling is that decision makers are utility maximizers, which implies that decision makers choose the alternative that maximizes their utility, given a set of alternatives. The utility of an alternative for an individual (U) cannot be observed; however, it can be assumed to consist of a deterministic (observable) component (V) and a random

error (unobservable) component (ε). Formally, an individual q's utility of alternative i can be expressed as follows:

$$U_{iq} = V_{iq} + \varepsilon_{iq} . \quad (1)$$

Hence, the probability that individual q chooses alternative i from a particular set J, which comprises j alternatives, can be written as the following:

$$P_{iq} = P(U_{iq} > U_{jq}; \textit{ for all } j(\neq i) \in J) = P(\varepsilon_{jq} < \varepsilon_{iq} + V_{iq} - V_{jq}; \textit{ for all } j(\neq i) \in J) . \quad (2)$$

To transform the random utility model into a choice model, certain assumptions regarding the joint distribution of the vector of random error components is required. If random error components are assumed to follow the type I extreme value (EV1) distribution and to be independently and identically distributed (IID) across alternatives and cases (or observations), a conditional logit model (McFadden, 1974) can be obtained. In the conditional logit model, the choice probability in Equation 2 is expressed as

$$P_{iq} = \frac{\exp(\mu V_{iq})}{\sum_{j=1}^{J} \exp(\mu V_{jq})} . \quad (3)$$

Further, assuming that the deterministic component of utility is linear and additive in parameters $V_{iq} = \beta' \mathrm{X}_{iq}$, the probability in Equation 3 can be rewritten as

$$P_{iq} = \frac{\exp(\mu \beta' \mathrm{X}_{iq})}{\sum_{j=1}^{J} \exp(\mu \beta' \mathrm{X}_{jq})} , \quad (4)$$

where μ represents a scale parameter that determines the scale of the utility, which is proportional to the inverse of the distribution of the error components. It is typically normalized to 1.0 in the conditional model. X_{iq} are the explanatory variables of V_{iq}, normally including alternative-specific constants (ASCs), the attributes of alternative i and socio-economic characteristics of individual q, and β' is the parameter vector associated with matrix X_{iq}.

Based on the above discussions, this study estimates two indirect utility functions.

Model 1: $V_{iq} = \beta_1 SN_i + \beta_2 PRICE_i$;

Model 2: $V_{iq} = \beta_1 SN_i + \beta_2 PRICE_i + \sum_k \gamma_k SN_i * INFO_{kq} + \sum_m \lambda_m SN_i * SOCIO_{mq}$,

where i represents ham sandwich A or B; k, Information 1-1, 1-2, 2, 3, 4, and price; SN, a dummy variable indicating that ham sandwich i contains sodium nitrite; $PRICE_i$, the price level of ham sandwich i; $INFO_{kq}$, a dummy variable indicating the reasons for choice k by individual q in rounds 4 to 6 after information about sodium nitrite is provided; and $SOCIO_{mq}$, the socioeconomic characteristics m of individual q. $SN * INFO_{kq}$ and $SN * SOCIO_{mq}$ are the interaction terms of SN

with $INFO_{kq}$ and $SOCIO_{mq}$, respectively. Finally, β_1, β_2, γ_k, and λ_m are the parameters to be estimated. The definition of variables applied in Models 1 and 2 is provided in Table 2.

Table 2 is around here

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4. Results

Figures 1 and 2 present the percentages of choosing ham sandwiches in the experiment and survey. As shown in Figure 1, the percentages of choosing ham sandwich A without sodium nitrite are greater than those of ham sandwich B with it in rounds 1, 2, 4, and 5, while the percentages of choosing ham sandwich A are smaller than those of choosing ham sandwich B in rounds 3 and 6. On the other hand, as shown in Figure 2, the percentages of choosing ham sandwich A are greater than those of choosing ham sandwich B in all rounds. Combining the prices of both ham sandwiches in each round with these percentages in the experiment and the survey samples, we can roughly ascertain that the subjects in the experiment are sensitive to price, while the participants in the survey are sensitive to the use of sodium nitrite (see more detailed discussions below).

Figures 1 and 2 are around here

4.1. Specification issue

The conditional logit results of Models 1 and 2 are presented in Tables 3, 4, and 5. The first issue discussed concerns the hypothesis of equal utility parameters among each subsample and the pooled sample categorized by information provision (i.e., pre-information, post-information, and pooled sample of pre-information and post-information). To test these hypotheses, we applied the likelihood ratio (LR) test suggested by Swait and Louviere (1993) using the log likelihood values obtained from estimating Model 1. The test was conducted in both the experiment and the survey samples (northern, southern, eastern, and central areas) and the pooled sample of the experiment and the survey, respectively. In addition, the issue concerning the subsample and pooled sample can also be found according to the data collection modes (i.e., the experiment and the survey and the survey subsample among the four investigated areas). Therefore, we should examine whether or not the data from these two methods could be pooled. All the LR statistics, which were calculated based on the

log likelihoods in Tables 3 and 4, rejected the hypothesis that the vector of common utility parameters is equal across subsamples in all the cases.[7] Therefore, the following analyses are based on the subsamples of the experiment and the four areas of the survey with respect to both pre- and post-information situations.

Tables 3 and 4 are around here

4.2. Effects of information as a whole

With respect to the results of Model 1, the two variables *SN* and *Price* are estimated with significant and negative signs in the experiment sample, which implies that the subjects prefer ham sandwiches without sodium nitrite and at a cheaper price, as shown in Table 3. With respect to the survey subsamples in Table 4, the variable *SN* is estimated with significant and negative signs in all areas, implying that the participants do not prefer sodium nitrite in all areas. The variable *Price* is estimated with significant and negative signs in the northern, eastern, and central areas, suggesting that the participants in these areas consistently conform to what the economic theory forecasts. These estimates of Model 1 are rather similar for the experiment and the survey.

However, the WTP estimates for the ham sandwiches not containing sodium nitrite in both the pre- and post-information situations in the experiment and survey appear to exhibit differences caused by information provision and potentially hypothetical (non-monetary incentive) bias. As shown in Table 3, WTP for a ham sandwich without sodium nitrite after information is provided is lower than that when pre-information is provided. This may suggest that the positive information about sodium nitrite dominates the negative information. In Table 4, WTP for a ham sandwich without sodium nitrite with respect to post-information is higher than that with respect to pre-information in the northern, eastern, and central areas, which implies that the participants value negative information more than positive information in these areas. The inverse net effect of information on WTP for the ham sandwiches not containing sodium nitrite in the experiment and survey is interesting because it exhibits a divergence in the choice behavior of a real monetary incentive situation (i.e., the experiment) and a hypothetical situation (i.e., the survey). Furthermore, the WTP estimates in the experiment are within the price level of ham sandwiches, which is considered to truly reflect the subjects' preferences regarding sodium nitrite. However, most of the WTP estimates in the survey are outside the range of the posted price, which suggests that these

[7] All the LR statistics are available upon request.

WTP estimates may be overstated in the survey subsamples owing to a lack of monetary incentive and real behavior (i.e., not eating).

4.3. Effects of information specified by choice reasons

To investigate the effect of information on choice behavior in further detail, we estimate Model 2 and report the results in Table 5. In the experiment, with respect to the variables associated with the effect of information specified by the choice reasons, four interaction terms with *SN* (i.e., *SN*info.1-1*, *SN*info.1-2*, *SN*info.2*, and *SN*info.4*) are significant. Most of the estimated signs of these variables are consistent with our expectations. For example, the subjects who chose information 1-1, which is considered to be positive information, as the determinant of choice are likely to favor sodium nitrite because of the positive signs of *SN*info.1-1*. The significantly negative sign of *SN*info.1-2* is slightly contradictory to our expectations because information 1-2 is considered to be weakly positive information. However, it is plausible that since the subjects who originally disliked food additives realized that according to information 1-2, there were no deaths due to foodborne botulism owing to sodium nitrite from 2000 to 2005, and the number of patients was quite low in the past decade, they may regard foodborne botulism as not risky and consequently respond with their original preference on sodium nitrite. Meanwhile, *SN*info.4* is positively estimated, which implies that the subjects favor good taste brought about by sodium nitrite. In addition, the negative sign of *SN*info.4* implies that the participants who reported information 4, which is considered to be negative information, as their choice reasons do not prefer sodium nitrite due to this negative information. Comparing the magnitude of these parameters, we find that the parameter of *SN*info.2* is the largest, which indicates that information about flavor has the largest marginal effect on the choice of ham sandwiches.[8] In the survey, the results of the interaction terms of *SN* with choice reasons vary across areas. In the northern area, the variables *SN*Info.1-1* and *SN*Info.2* are estimated with significant and positive signs, while the variables *SN*Info.3* and *SN*Info.4* are estimated with significant and negative signs. In southern area, the variable *SN*Info.1-2* is estimated with a significant and positive sign. The variable *SN*Info.4* is estimated with a significant and negative sign. In the eastern area, the variable *SN*Info.2* is estimated with a significant and positive sign. The variables *SN*Info.3* and *SN*Info.4* are estimated with significant and negative signs. In the central area, the variable *SN*Info.4* is estimated with a significant and negative sign. In sum, in the survey, negative information 3 and 4 appear to more significantly affect the participants' choice of ham sandwiches than positive information 1-1 and 1-2 do. Furthermore, comparing the magnitude of these parameters, we find that the parameter of *SN*info.4* is the largest

[8] Strictly speaking, the parameters here refer to the marginal utility of choice. However, since it is estimated by the conditional logit model, the sign and magnitude relation of the utility parameters are consistent with those of the marginal effect on choice probability.

in each area, which indicates that the information on possible carcinogenesis caused by the ham sandwiches containing sodium nitrite has the largest marginal effect on the choice of ham sandwiches.

Summarizing the above discussions, we find that the information about flavor caused by the inclusion of sodium nitrite has the largest effect in the experiment, while the effect of information on possible carcinogenesis is larger than those of other information in the survey. This result implies that information about food additives indeed affects consumers' choices in food differently according to different conditions (e.g., eating and not eating, monetary incentive and no monetary incentive, etc.). Therefore, analysts in this field should conduct further research on real conditions such as eating and tasting and real monetary incentives.

With respect to the variables associated with choosing price as choice reasons, *SN*price_r5* is not significant and *SN*price_r6* is significant in the experiment. The significantly positive sign of *SN*price_r6* was expected because in round 6, the price of the ham sandwich containing sodium nitrite is lower than the one not containing sodium nitrite. This result is similar to those obtained in the survey.

Table 5 is around here

4.4. Effect of socioeconomic characteristics in the survey

The results of the effect of socioeconomic characteristics on the choice of ham sandwiches in the survey sample are also reported in Table 5. First, we observe that several variables associated with occupation are significant in the eastern and central areas, whereas no occupational variables are significant in the other two areas except for housewife in the southern area. For example, it was found that a significant number of self-employed and retired participants in both areas, public employees and private business employees in the eastern area, and housewives and part-time employees in the central area do not prefer ham sandwiches with sodium nitrite. Next, two household income variables are estimated with significant and positive signs in the northern and central areas, which implies that the higher the income of the participant's household, the more likely he or she is to choose a ham sandwich containing sodium nitrite. In addition, the effects of household size and gender on the preferability of sodium nitrite are found to differ among areas, whereas age appears to have no influence.[9]

[9] We also tried to include another socioeconomic characteristic—the ratio of household monthly meal expenses—in model 2. However, due to its insignificance in all areas, we excluded it from the final estimation model.

The above results are interesting if we discuss them partly combined with several characteristics of each area. In Osaka prefecture, the average distribution of income is highest in the northern area, average in the central area, and lowest in the southern and eastern areas. This supportive evidence proves that household income plays a significant role in ham sandwich preference in the northern and central areas because, on average, a ham sandwich containing sodium nitrite is priced relatively higher in Japan. In addition, Northern and Southern Osaka are residential areas, while Central Osaka is a commercial center and Eastern Osaka is an industrial district replete with small- and medium-sized enterprises. Thus, occupation is an important factor in the eastern and central areas but not in the northern and southern areas.

5. Conclusion

This study examined whether introducing information about a food additive (i.e., sodium nitrite) affects consumers' choice of ham sandwiches under real and hypothetical conditions using the choice experiment method. In the real condition (i.e., the laboratory experiment), the subjects were asked to purchase one ham sandwich with the money provided and eat it, while in the hypothetical condition (i.e., the field survey), the participants were asked only to choose one favorite ham sandwich without buying or eating it. In both the conditions, the participants were asked to make their selection three times each before and after the information about sodium nitrite was provided. The information consisted of positive information referring to the benefits of using sodium nitrite (e.g., preventing foodborne botulism and creating a good flavor) and negative information about the health risks of using sodium nitrite (e.g., the probability of it causing cancer).

We obtain the following results. First, the WTP values for the ham sandwiches without sodium nitrite in the laboratory experiment in both pre- and post-information situations are lower than those in the field survey. This result supports the so-called hypothetical bias found partly in Lusk and Schroeder (2004), List and Gallet (2001), and Kruse and Thompson (2003), which indicates that both economic incentive and eating behavior can significantly affect food choice. Second, the WTP estimates with respect to post-information are lower than those with respect to pre-information in the experiment and higher than those concerning post-information in the survey. This implies that positive information as a whole dominates the negative information in the experiment and *vice versa* in the survey. Third, in the experiment, information about flavor as a determinant has the greatest effect on the choice of a ham sandwich with sodium nitrite than other information does. This evidence supports the result of Prescott et al. (2002) that sensory properties affect more than information during tasting does. In addition, in the survey, the result that health risk information plays the most important role in influencing of ham sandwich selection also supports the evidence found in previous studies (e.g., Shogren et al., 1994; Fox et al., 2004; Hayes et al., 2004). Fourth, a

number of socioeconomic characteristics such as occupation, household income, household size, and gender are found to affect the choice of ham sandwiches containing sodium nitrite.

Finally, this study suggests the significance of two possible areas for further research. First, in the current study, information about sodium nitrite was provided on an information sheet. Therefore, we can only judge the effect of information about choice behavior discretely. Manipulating the benefits and health risks of food additives into choice sets could be viewed as a better alternative. Second, the results in the experiment were based on the choice behavior of the students in Osaka University. It should be noted that in experiments that aim at investigating food choice, subjects with different socioeconomic characteristics are given more consideration. Therefore, future studies on this issue should be conducted by recruiting other members of society. We believe that for a successful food choice experiment, both real factors (e.g., real economic incentive, eating or tasting, etc.) and targeted participants are necessary.

Acknowledgements

We would like to acknowledge the financial support provided by the Ito Foundation and the Japanese Ministry of Education, Culture, Sports, Science and Technology (the COE program of Behavioral Macrodynamics based on Surveys and Experiments; the Grant-in-Aid for Scientific Research on Priority Areas). We would also like to thank the participants of the 11th Experimental Social Sciences Conference in Japan (2007) and the Agricultural Economics Society of Japan Annual Meeting (2008) for their helpful suggestions. The assistance in conducting the experiment and survey of Kenju Akai, Tomoki Ando, Chieko Fujisawa, Katsuhiko Nishizaki, and Kenta Onoshiro is also greatly valued.

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Appendix:

Appendix A: Instructions for the experiment (original text in Japanese)

You are participating in an experiment that is designed to study decision making. In this experiment, you will be asked to buy one of two types of ham sandwiches, which we will provide, and eat it. Please understand and follow the instructions carefully. In addition, you cannot communicate with others during the experiment or take any remaining ham sandwiches with you after the experiment is completed.

Overview

This experiment consists of six rounds. In each round, you must choose one of two types of ham sandwiches, which we will provide, pay for it with the money given to you, and eat it. At the end of the experiment, you will receive your earnings in cash based on the formula below:

Earnings = 6 * {initial income in each round (200 JPY) – the price of the ham sandwiches chosen in each round} + show-up fee (1000 JPY)

Rules

At the beginning of round 1, you shall receive 200 JPY to buy a ham sandwich. However, you will not actually receive that amount in cash in each round. Please imagine that you have 200 JPY in each round before you make your choice.

Next, you will receive a box containing two types of ham sandwiches and a record sheet. Please open the box and remove the record sheet. Verify the accuracy of your seat number and the number of the round on it.

We shall now consider an example of a "record sheet." This is a record sheet for seat number 1 in round 1 as an example. Further, we shall explain how to read and fill in the record sheet. The top line, stating "record sheet," "round 1", implies the number of the round, and "seat number 1" implies that the seat numbering starts from the left hand side of the room. The second line indicates a variety of ham sandwiches—Ham Sandwich A without sodium nitrite and Ham Sandwich B with sodium nitrite. The fourth line indicates the price levels of the ham sandwiches in JPY. Here, since it is an example, the price levels of the two ham sandwiches are symbolized as "a" and "b." The price of ham sandwiches in each round of the experiment is less than the money you receive to buy it. The last line provides the column for you to indicate your decision. Please tick in the square that corresponds to the ham sandwich you have selected. For example, if you choose Ham Sandwich A, you should tick the square in the column for Ham Sandwich A.

After you choose the ham sandwich and tick the square, you are asked to mention the reason why you chose it in the column "why did you choose the ham sandwich?" After completing the record sheet, place it back in the box and remove the selected ham sandwich from the box. Finally, close the box and wait for the experimenter to collect it.

The experimenter shall collect all the boxes in the room. After the experimenter announces "please begin eating," you should start eating the ham sandwich. After you finish eating, you must drink a glass of mineral water (approximately 10 ml), which we provide. This completes round 1. The rules in round 2 are exactly the same as those in round 1. Initially, you receive 200 JPY, and then, you receive a box containing two types of ham sandwiches and a record sheet. You purchase one of the two types of ham sandwiches and eat it. After the completion of round 2, round 3 begins. This experiment is repeated a total of six times following the same rules. The completion of round 6 signals the end of the experiment.

Earnings

Earnings are calculated as the amount equal to the sum of the show-up fee and total of the remaining amounts in six rounds. The show-up fee is 1,000 JPY. Since this amount is a reward for your participation, it is not affected by your choice in each round.

Next, we explain the remaining amounts in the six rounds. At the beginning of each round, you receive 200 JPY to buy one ham sandwich. The remaining amount in each round is equal to the difference between 200 JPY and the price of the ham sandwich you choose. This amount constitutes your earnings in each round. Since this experiment consists of six rounds, you receive the sum of the remaining amount for six rounds. The formula for you earnings in the experiment is provided below.

Earnings = 1,000 JPY (show-up fee)
+ {(200 JPY – the price of the ham sandwich you buy in round 1)
+ (200 JPY – the price of the ham sandwich you buy in round 2)
+...+ (200 JPY – the price of the ham sandwich you buy in round 6)}

You need not be conscious of others because we never offer your earnings to others. This explains the experiment. Please understand the rules of the experiment, select the ham sandwich that you wish to purchase, and eat it.

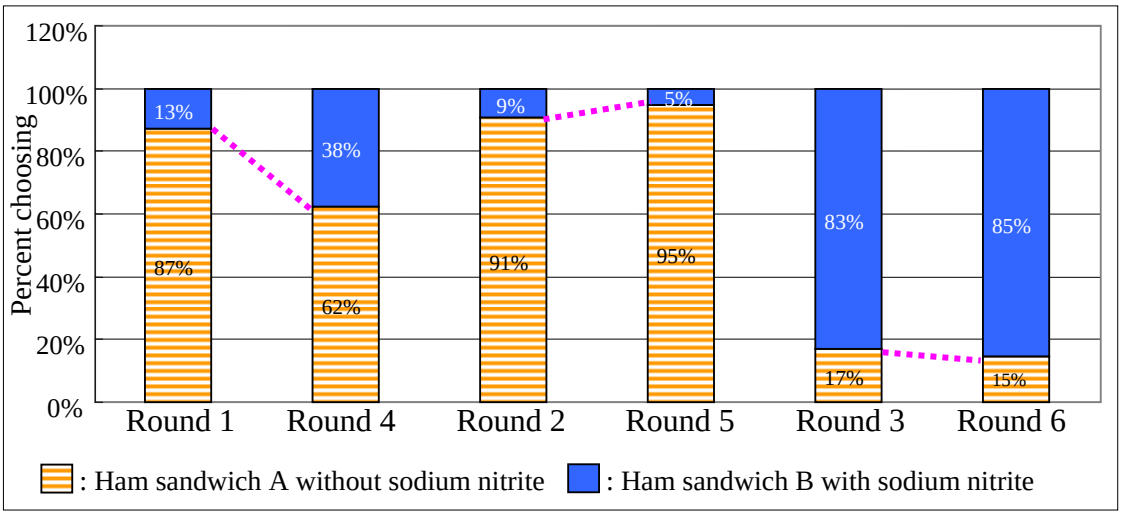
Are there any questions before we begin?

Appendix B: Socioeconomic characteristics of field survey and laboratory experiment samples

Characteristics	Field survey		Characteristics	Experiment	
	n	%		n	%
Gender			*Gender*		
Male	157	35.32	Male	100	85.47
Female	280	62.99	Female	17	14.53
No answer	8	1.69	No answer	0	0.00
Age (years)			*Age (years)*		
Below 20	23	5.17	Below 20	28	23.93
20–29	53	11.92	20–24	79	67.52
30–39	85	19.12	Above 25	10	8.55
40–49	88	19.80	No answer	0	0.00
50–59	79	17.77			
60–69	66	14.85			
Over 70	47	10.57			
No answer	4	0.79			
Household size			*Livelihood*		
1 person	75	16.87	Stay alone	78	66.67
2 persons	113	25.42	With family	39	33.33
3 persons	128	28.80	No answer	0	0.00
4 persons	80	18.00			
5 persons	32	7.20			
6 persons	11	2.47			
Above 7 persons	1	0.22			
No answer	5	1.01			
Family structure					
Single	69	15.52			
Married couple without child	84	18.90			
Parent-child	246	55.34			
Three-generation family	18	4.05			
Others	14	3.15			
No answer	14	3.04			
Occupation					
Self-employed	45	10.12			
Private business employee	90	20.25			
Public employee/teacher	30	6.75			
Part-time job	62	13.95			
Housewife	87	19.57			
Student	37	8.32			
Retired	54	12.15			
Other	33	7.42			
No answer	7	1.46			
Household monthly income (JPY)			*Monthly disposable income besides room rental expenses (JPY)*		
< 100,000	34	7.65	< 10,000	4	3.42
100,000–199,999	60	13.50	10,000–29,999	40	34.19
200,000–299,999	94	21.15	30,000–49,999	29	24.79
300,000–399,999	80	18.00	50,000–69,999	31	26.49
400,000–499,999	65	14.62	>= 70,000	13	11.11

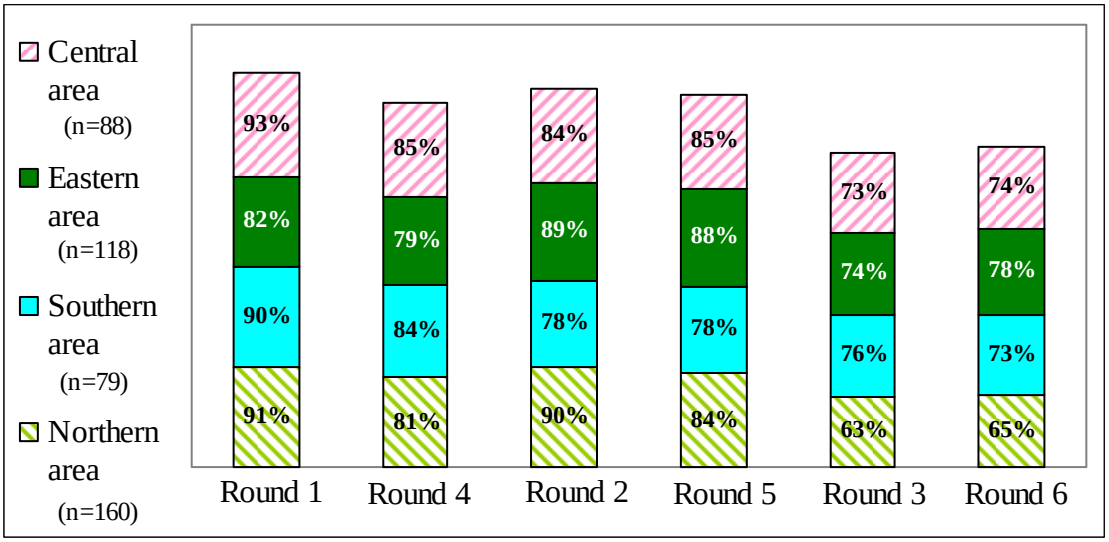
>= 500,000	70	15.75	No answer	0	0
No answer	42	9.34			
Ratio of household monthly meal expenses to income			*Ratio of monthly meal expenses to income*		
< 5%	12	2.70	< 10%	5	4.27
5–9.99%	71	15.97	10–19.99%	10	8.55
10–14.99%	73	16.42	20–29.99%	23	19.66
15–19.99%	91	20.47	30–39.99%	30	25.64
20–24.99%	76	17.10	40–49.99%	24	20.51
>= 25%	60	13.50	>= 50%	25	21.37
No answer	62	13.84	No answer	0	0
Total observation	445	100		117	100

Figure 1. Results of choosing ham sandwiches in the laboratory experiment (by percentage)



Notes: The prices of ham sandwich A and B are the same in rounds 1 and 4. In rounds 2 and 5, the price of ham sandwich A is lower than that of ham sandwich B, while in rounds 3 and 6, the price of ham sandwich A is higher than that of ham sandwich B. Rounds 1 to 3 are pre-information situations, and rounds 4 to 6 are post-information situations. The total number of participants is 117.

Figure 2. Results of choosing ham sandwich A without sodium nitrite in the survey (by percentage)



Notes: The prices of ham sandwich A and B are the same in rounds 1 and 4. In rounds 2 and 5, the price of ham sandwich A is lower than that of ham sandwich B, while in rounds 3 and 6, the price of ham sandwich A is higher than that of ham sandwich B. Rounds 1 to 3 are pre-information situations, and rounds 4 to 6 are post-information situations. The total number of participants is 445.

Table 1. Choice sets in the experiment

Pre-information:

Round 1

	Ham sandwich A not containing sodium nitrite	Ham sandwich B containing sodium nitrite
Price	¥50	¥50
I would choose…		

Round 2

	Ham sandwich A not containing sodium nitrite	Ham sandwich B containing sodium nitrite
Price	¥50	¥80
I would choose…		

Round 3

	Ham Sandwich A not containing sodium nitrite	Ham sandwich B containing sodium nitrite
Price	¥80	¥50
I would choose…		

Post-information:

Round 4

	Ham sandwich A not containing sodium nitrite	Ham sandwich B containing sodium nitrite
Price	¥50	¥50
I would choose…		
Two most important reasons affecting my choice	☐Information 1-1 ☐Information 1-2 ☐Information 2 ☐Information 3 ☐Information 4	

Round 5

	Ham sandwich A not containing sodium nitrite	Ham sandwich B containing sodium nitrite
Price	¥50	¥80
I would choose…		
Two most important reasons affecting my choice	☐ Information 1-1 ☐ Information 1-2 ☐ Information 2 ☐ Information 3 ☐ Information 4 ☐ Price	

Round 6

	Ham sandwich A not containing sodium nitrite	Ham sandwich B containing sodium nitrite
Price	¥80	¥50
I would choose…		
Two most important reasons affecting my choice	☐ Information 1-1 ☐ Information 1-2 ☐ Information 2 ☐ Information 3 ☐ Information 4 ☐ Price	

Table 2. Definitions of variables

Variables	Definition
SN	A dummy variable = 1 if the ham sandwich contains sodium nitrite.
Price	Price of the ham sandwich.
SN*Info. 1-1	An interaction term of SN with a dummy variable that equals 1 if Info. 1.1 is chosen as the reason for the choice after information is provided.
SN*Info. 1-2	An interaction term of SN with a dummy variable that equals 1 if Info. 1.2 is chosen as one of the reasons for the choice after information is provided.
SN*Info. 2	An interaction term of SN with a dummy variable that equals 1 if Info. 2 is chosen as one of the reasons for the choice after information is provided.
SN*Info. 3	An interaction term of SN with a dummy variable that equals 1 if Info. 3 is chosen as one of the reasons for the choice after information is provided.
SN*Info. 4	An interaction term of SN with a dummy variable that equals 1 if Info. 4 is chosen as one of the reasons for the choice after information is provided.
SN*Price_r5	An interaction term of SN with a dummy variable that equals 1 if price is chosen as one of the reasons for the choice in round 5.
SN*Price_r6	An interaction term of SN with a dummy variable that equals 1 if price is chosen as one of the reasons for the choice in round 6.
SN*self-employed	An interaction term of SN with a dummy variable that equals 1 if the respondent is self-employed.
SN*private business employee	An interaction term of SN with a dummy variable that equals 1 if the respondent is a private business employee.
SN*public employee/teacher	An interaction term of SN with a dummy variable that equals 1 if the respondent is a public employee/teacher.
SN*part-time	An interaction term of SN with a dummy variable that equals 1 if the respondent has a part-time job.
SN*housewife	An interaction term of SN with a dummy variable that equals 1 if the respondent is a housewife.
SN*student	An interaction term of SN with a dummy variable that equals 1 if the respondent is a student.
SN*retired	An interaction term of SN with a dummy variable that equals 1 if the respondent is retired.
SN*high_income	An interaction term of SN with a dummy variable that equals 1 if the respondent's monthly household income is more than 400,000 JPY.
SN*middle_income	An interaction term of SN with a dummy variable that equals 1 if the respondent's monthly household income is between 100,000 and 399,999 JPY.
SN*household_size	An interaction term of SN with household size.
SN*female	An interaction term of SN with a dummy variable that equals 1 if the respondent is female.
SN*young	An interaction term of SN with a dummy variable that equals 1 if the respondent's age is less than 29 years.
SN*middle_age	An interaction term of SN with a dummy variable that equals 1 if the respondent's age is between 30 and 59 years.

Table 3. Results of Model 1 for the laboratory experiment sample

Variables	Pre-info.	Post-info.
SN	–1.527 **	–0.721**
Price	–0.085 **	–0.088**
Marginal willingness to pay (JPY)	17.96	8.19
Log likelihood	–227.461	–237.005
McFadden's R^2	0.351	0.324
Observations	702	702

Notes: Standard deviations or *z* statistics are not reported to save space. ** and * denote that the parameters are different from zero at 1% and 5% significance levels, respectively.

Table 4. Results of Model 1 for the survey sample

Variables	Northern area		Southern area		Eastern area		Central area	
	Pre -info.	Post -info.	Pre -info.	Post -info.	Pre -info.	Post -info.	Pre -info.	Post -info.
SN	–2.513**	–1.963**	–2.267**	–2.024**	–2.367**	–2.268**	–2.499**	–2.317**
Price	–0.043**	–0.024**	–0.004	–0.007	–0.023**	–0.015*	–0.019*	–0.017**
Marginal willingness to pay (JPY)	58.44	81.79	-	-	102.91	151.20	131.53	136.29
Log likelihood	–292.980	–394.241	–155.584	–170.277	–224.714	–232.764	–159.449	–171.483
McFadden's R^2	0.390	0.268	0.343	0.281	0.364	0.342	0.397	0.352
Observations	960	954	474	474	708	708	528	528

Notes: Standard deviations or *z* statistics are not reported to save space. ** and * denote that the parameters are different from zero at 1% and 5% significance levels, respectively.

Table 5. Results of Model 2 for laboratory experiment and field survey samples

	Experiment	Northern area	Southern area	Eastern area	Central Area
Variables					
SN	–0.864**	–3.913**	–3.755**	–3.039**	–3.000*
Price	–0.098**	–0.028**	–0.006	–0.013	–0.019*
SN*Info. 1-1	2.116*	1.048**	–0.192	–0.123	1.065
SN*Info. 1-2	–3.175*	–0.369	0.990*	–0.298	–0.244
SN*Info. 2	3.314**	2.683**	0.457	3.045**	0.989
SN*Info. 3	–0.274	–1.217*	–0.668	–3.089**	–0.825
SN*Info. 4	–2.988**	–3.542**	–2.574**	–4.735**	–4.212**
SN*Price_r5	–1.476	–0.180	–0.434	–2.734	–0.202
SN*Price_r6	2.775**	3.420**	0.673	1.774**	3.520**
SN*self-employed		0.190	0.047	–3.611**	–3.466**
SN*private business employee		1.580	–0.384	–1.220	–3.938**
SN*public employee/teacher		–1.000	–0.359	–3.604**	0.071
SN*part-time		0.854	–0.873	0.475	–3.935**
SN*housewife		–0.393	–3.744**	–0.076	–3.112*
SN*student		–1.130	–2.265	–1.308	–22.688
SN*retired		0.350	0.887	–3.864**	–3.215**
SN*high_income		1.682**	–0.578	1.227	1.607**
SN*middle_income		1.183*	–0.366	0.181	0.618*
SN*household_size		–0.533	0.533*	–0.873**	–0.625*
SN*female		0.989*	1.238*	–1.598**	–0.910
SN*young		2.191*	1.195	–0.716	–2.220
SN*middle_age		0.490	1.301	–0.920	–0.265
Log likelihood	–169.122	–228.893	–139.693	–158.677	–108.072
McFadden's R^2	0.518	0.514	0.410	0.543	0.591
Observations	702	942	474	696	528

Notes: Standard deviations or *z* statistics are not reported to save space. ** and * denote that the parameters are different from zero at 1% and 5% significance levels, respectively.