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Estimating Family Preference for Home Elderly-care Services: Large-scale Conjoint Survey Experiment in Japan[1*]

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Abstract

Elderly care services have attracted attention in many aging countries. However, the relative importance of service attributes has not been well evaluated. This paper estimates the consumer surplus of multi-attribute elderly care services at home, which allows us to evaluate them from the social welfare perspective. We propose a new empirical approach combining a fully-randomized conjoint survey experiment and the non-parametric rational choice model. Our survey is for Japanese respondents aged 40-59 and shows that expansions of service contents significantly increases the consumer surplus. Additionally, the surplus gain is completely heterogeneous; while many respondents have no surplus gains, the average surpluses are of significant size among remaining respondents.

JEL code: C25, J14,

Key words: Conjoint survey experiment, empirical welfare analysis, elder care

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1. Introduction

Sustainability of elderly services is an urgent matter for aging societies. For instance, 4.57M Japanese people were certified as eligible for public elderly-care services in 2017, whereas there were 2.10M in 2007. The change in demographics causes a shift in the supply of elderly-care from family members to the market. Currently, 20.2% of certified members use some market services.

The Japanese government has provided various policies to improve the quality of the elderly-care market. To make better policies and markets, understanding user preference for care service attributes is important. Economic theory provides many quantity summarizing their preference. Especially, aggregate demand and consumer surplus are most popular quantities.

Despite its importance, there are few studies estimating those quantities. One key difficulty is high dimensionality of the service, meaning that elderly-care services are characterized not only by price but also by service quality. From observed data, there are strong correlations between service quality and price, which implies the serious identification problem.

To overcome the problem, the present paper proposes a new approach combining the full-randomized conjoint survey-experiments (Hainueller, Hopkins, and Yamamoto, 2014) and a non-parametric rational choice model (Bhattacharya, 2015 & 2018, Hausman & Newey, 2016 & 2017).

The approach allows us to empirically identify the welfare impact of various counterfactual scenario. For instance, we can estimate the surplus change by making available holiday care-service.

We use a large scale online survey “Internet Survey on the Demand for Home Nursing Care” for 22,000 Japanese respondent whose age between 40 to 59 old. They observe two hypothetical services and then ask their preference for services; whether to use the each service or not and which service is preferred.

The surveyis conducted by the Research Institute of Economy, Trade, and Industry (implemented by the Rakuten insight, Inc..

Each care service is characterized by five non-monetary attributes, including usage of (1) daycare, (2) holiday care service, (3) support for daily activity, (4) monitoring by ICT, and (5) naming the care worker, and service fee.

Main finding is that all attributes robustly increase the consumer surplus. An important note is that last three attributes (support for daily activity, monitoring by ICT, naming the care worker) are not covered by the public insurance in Japan. Therefore, our results show that the consumer surplus is increased by providing more care-services even with high service fee.

2. Background

2.1. Social background

Japan is currently the oldest nation in the world. The total 2017 population was 126.79M, of which 34.29M (27%) were aged 65 and over. That is significantly higher than the U.S. (15%) and other Asian countries, including South Korea (14%), China (11%), and Singapore (13%).

To deal with aging, beginning in 2000, Japan implemented Long-Term Care Insurance (LTCI), a mandatory public program that provides benefits for the long-term care of older persons. The LTCI obligates all people aged 40 and over to contribute to the program by paying a premium that varies according to income, guaranteeing that all people aged 65 and over can access the same benefits, including institutional, home, and community-based services, regardless of income. All services were subject to a 10% co-payment when used. Whereas the number of insured persons aged 65 and over has

increased by approximately 1.6 times over the 16 years since 2000 (21.65M), the number of service users reached 6.14M, which is approximately four times higher over the same period.

As aging proceeds, insurance premiums (national average per month) are estimated to rise from ¥5,514 currently to ¥6,771 yen in 2020 and ¥8,165 in 2025. Because of the boom in the aging population, the LTCI has been reformed. Thus, with the current LTCI, co payments are 10% or 20%, depending on income level.

Given the choice, most elderly (74%) would prefer to continue to live in their own home to receiving the home care services.

2.2. Literature background

The paper evaluates the elderly care service by the conjoint survey experiment which is a variant of the discrete choice experiments. While the discrete choice experiment is widely used for the health care (for instance, Green & Gerard 2009, Flynn, Louviere, Peters, & Coast 2007), there are few research for the elderly care.

Especially, there are no studies for Japanese preference, excepting Ii & Ohkusa (2002) and Shimizutani & Noguchi (2004), and Kaneko, Kawata, & Yin (2018). While Ii & Ohkusa (2002) and Shimizutani & Noguchi (2004) provide only demand analysis, our paper provides not only demand but also robust welfare analysis.

The most closely related paper is Kaneko, Kawata, & Yin (2018). Their paper also provide the welfare analysis of the elderly care service. However, due to the data limitation, the average surplus is not pointy identified. Moreover, the present paper provides more comprehensive framework of welfare analysis.

3. Conceptural framework

The section introduces the conceptual framework to obtain the policy implications from conjoint data. The full-randomized conjoint survey experiment provides rich implications, which allows us to estimate not only elderly-care demand but also welfare implications.

3.1. Potential outcome model

This section shows the framework of the empirical welfare analysis by connecting the rational choice and the potential outcome frameworks (Rubin 1974). The unit of analysis is an elderly-care service, which is characterized by non-monetary attributes a and the elderly care cost p.

To the welfare analysis, three types of potential outcome are defined. The first outcome is *external chocie*, $Y_i^E(a,p)$, which is equal to 1 if a respondent i prefers a service $\{a,p\}$ than status-quo, and is equal to 0 otherwise.

The second is referred as *internal chocie*, $Y_i^I(a,p,a',p')$, which is 1 if the respondent prefers the service than an alternative service $\{a',p'\}$ and 0 otherwise. The final outcome is *total choice*, $Y_i^T(a,p,a',p')$, which is $=1$ if the respondent prefers the service $\{a,p\}$ than both status-quo and the alternative $\{a',p'\}$ and 0 otherwise.

3.1.1. Average marginal component effects

Before introducing the rational choice framework, the average marginal component effect (AMCE, Hainueller, Hopkins, and Yamamoto 2014) is defined. The AMCE captures the causal effects of attributes on a choice probability, which can be interpreted as the demand analysis in our context.

There are three types of AMCEs because the potential outcome variables are also three types. The AMCE on the external choice is defined as

$$\sum_{a_{-l},p} E\left[Y_i^E(a_1, a_{-l}, p) - Y_i^E(a_0, a_{-l}, p)\right] \times f(a_{-l}, p),$$

where a_{-l} is a vector of monetary attributes excluding an attribute l. The AMCE on the internal and total choice are,

$$\sum_{a_{-l},p,a',p'} E\left[Y_i^J(a_1, a_{-l}, p, a', p') - Y_i^J(a_0, a_{-l}, p, a', p')\right] \times f(a_{-l}, p, a', p'),$$

for any $J \in \{I, T\}$.

3.2. Rational choice model

To draw welfare implications from conjoint data, a rational choice framework is now introduced. Let $u_i(a, p)$ be the utility function if they use a service$\{a, p\}$ where a is a vector of attributes, and p is price. $u_i(\phi, 0)$ indicates the utility if she/he does not use any services.

Assuming the following property;

- $u_i(a, p)$ is a continuous and decreasing function of p.
- $u_i(a, p) \geq v_i(\phi, 0)$ if and only if $Y_i^E(a, p) = 1$.
- $u_i(a, p) \geq u_i(a', p')$ if and only if $Y_i^I(a, p, a', p') = 1$.
- $u_i(a, p) \geq \max\{u_i(a', p'), v_i(\phi, 0)\}$ if and only if $Y_i^T(a, p, a', p') = 1$.

An advantage of our approach is that above assumptions are enough, in other words, any parametric assumptions are not required.

3.3. Welfare analysis

The rational choice framework allows us to identify consumer surplus in three counterfactual scenarios.

3.3.1. Welfare implications from external choice

In the first scenario, household i faces a choice problem; whether using a service $\{a, p\}$ or not using at all. The individual surplus, c_i^E, is defined as

$$\max\{u_i(a, p + c_i^E), u_i(\phi, c_i^E)\} = u_i(\phi, 0),$$

which can be rewritten as

$u_i(a, p + c_i^E) = u_i(\phi, 0)$ if and only if $c_i^E \geq 0$,

and

$c_i^E = 0$ if and only if $u_i(a, p) < u_i(\phi, 0)$.

Note that c_i^E depends on both non-monetary attributes a and costs p.

The following proposition shows that the surplus distribution is identified by the conditional average function of Y_i^E.

Proposition 1. The surplus distribution and it's marginalized distribution are identified as

$$\Pr[c_i^E \leq C|a, p] = 1 - E[Y_i^E|a, p + C],$$

and

$$\Pr[c_i^E \leq C|a_l, p] = 1 - E[Y_i^E|a_l, p + C].$$

Proof See Appendix.

3.3.2. Welfare implications from internal choice

Consider the second scenario where an original choice set includes only a service $\{a, p\}$, which then expands a choice set including two services $\{a, p\}$ and $\{a', p'\}$. The section wishes to identify the surplus resulting from the expansion of the choice set.

The individual surplus, c_i^I, is defined as

$$\max\{u_i(a, p + c_i^I), u_i(a', p + c_i^I)\} = u(a', p),$$

which can be rewritten as

$u_i(a, p + c_i^I) = u_i(a', p)$ if and only if $c_i^I \geq 0$,

and

$c_i^I = 0$ if and only if $u_i(a, p) < u_i(a', p)$.

The following proposition shows that the surplus distribution is identified by the conditional average function of Y_i^I.

Proposition 2. The surplus distribution and it's marginalized distribution are identified as

$$\Pr[c^I \leq C | a, a', p] = 1 - E[Y_i^I | a, p, a', p + C],$$

and

$$\Pr[c^I \leq C | a_l = 1, a'_l = 0, a_{-l} = a'_{-l}] = 1 - E[Y_i^I | a_l = 1, a'_l = 0, a_{-l} = a'_{-l}, p - p' = C]$$

Proof See Appendix.

3.3.3. Welfare implications from total choice

Consider the third scenario where an original choice set includes using a service $\{a, p\}$ and not using at all, which then expands a choice set including three options, using a service $\{a, p\}$, another service $\{a', p\}$, and not using at all. We identify the surplus resulting from the expansion of the choice set.

The individual surplus, c_i^T, is defined as

$$\max\{u_i(a', p + c_i^T), u_i(a, p + c_i^T), u_i(\phi, c_i^T)\} = \max\{u_i(a', p), u_i(\phi, 0)\},$$

which can be rewritten as

$u_i(a, p + c_i^T) = \max\{u_i(\phi, 0), u_i(a', p^T)\}$ if and only if $c_i^T \geq 0$,

and

$c_i^T = 0$ if and only if $\max\{u_i(\phi, 0), u_i(a', p)\}$.

The following proposition shows that the surplus distribution is identified by the conditional average function of Y_i^T.

Proposition 3. The surplus distribution and it's marginalized distribution are identified as

$$\Pr[c_i^T \leq C | a, a', p] = 1 - E[Y_i^T | a, a', p],$$

and

$$\Pr[c_i^T \leq C | a_l = 1, a'_l = 0, a_{-l} = a'_{-l}] = 1 - E[Y_i^T | a_l = 1, a'_l = 0, a_{-l} = a'_{-l}].$$

Proof See Appendix.

3.3.4. Average surplus

Proposition 1, 2, and 3 immediately apply to the average surplus. The following corollary shows identified average surplus.

Corollary 1. The average surplus are identified as

$$E[c_i^E|a,p] = \int_0^\infty Y_i^E\,(a,p+C)dC,$$

and

$$E[c_i^J|a,a',p] = \int_0^\infty Y_i^J\,(a,p+C,a',p)dC,$$

for any $J \in \{I,T\}$.

4. Survey design

Proposition 1, 2, and 3 require identifications of $E[Y_i^E|a,p]$, $E[Y_i^I|a,p,a',p']$, and $E[Y_i^T|a,p,a',p']$. Hainmueller, Hopkins, & Yamamoto (2014) proposes a relevant approach, full-randomized conjoint survey experiment, which provides a choice data with randomized variation of a and p.

We conduct an internet conjoint experiment, which was carried out by the Rakuten insight, Inc.in Octorber 2018. We correct 22,000 respondentswhose age is between 40 to 59. Within them, 20,790 are selected to use statistical analysis. They have parents and then potentially care them. All respondents are followed the same procedure; (1) a conjoint experiment for elderly care service, (2) a conjoint experiment for elder policies, and (3) the background survey. Note that the present paper does not use the second experiment result.

In the conjoint survey, a respondent first reads a common scenario; “One of your parents now needs to care for walking, toilet, and buss. You have three options; (1) using the elderly-care facility A, (2) using the elderly care facility B, and (3) do not use both services. Attributes of those services are shown in the following table. Note that both provide same services for attributes not shown in the table” After that, they ask to complete 5 choice tasks. In each choice task, two options of hypothetical elderly care services are presented, and the respondent are asked whether she/he would like to use each of the two services.

First, daily life supporting such as substituting the aged in shopping and/or in barbershops/hairdressing and offering co-residence a cooked meal, utilization of ICT for watching system, naming a home helper, which are called combined care service, are all confirmed to have an intuitive impact on demand.

Each care service is characterized by six attributes, including usage of (1) daycare service, (2) holiday care service, (3) support for daily activity (e.g., shopping and/or in barbershops/hairdressing and offering co-residence a cooked meal), (4) monitoring by ICT, (5) naming the care workers, and (6) service fees. Levels of those attributes are pure-randomly selected from the list of potential levels.

List of potential attribute levels is

- Daycare: (i) Available, (ii) Not available.
- Holiday: (i) Available, (ii) Not available.
- Daily activity: (i) Available, (ii) Not available.
- ICT: (i) Available, (ii) Not available.
- Naming: (i) Available, (ii) Not available.
- Costs: Between 5 thousands JPY and 30 thousands JPY.

The background survey collects the information of basic characteristics, for instance, gender, age, education level, living location, and family structure of respondents. Additionally, situations of their parent are also collected.

5. Results

5.1. AMCEs on choice probabilities

First, the following figure shows estimated AMCE on the internal, external, and total choice probabilities.

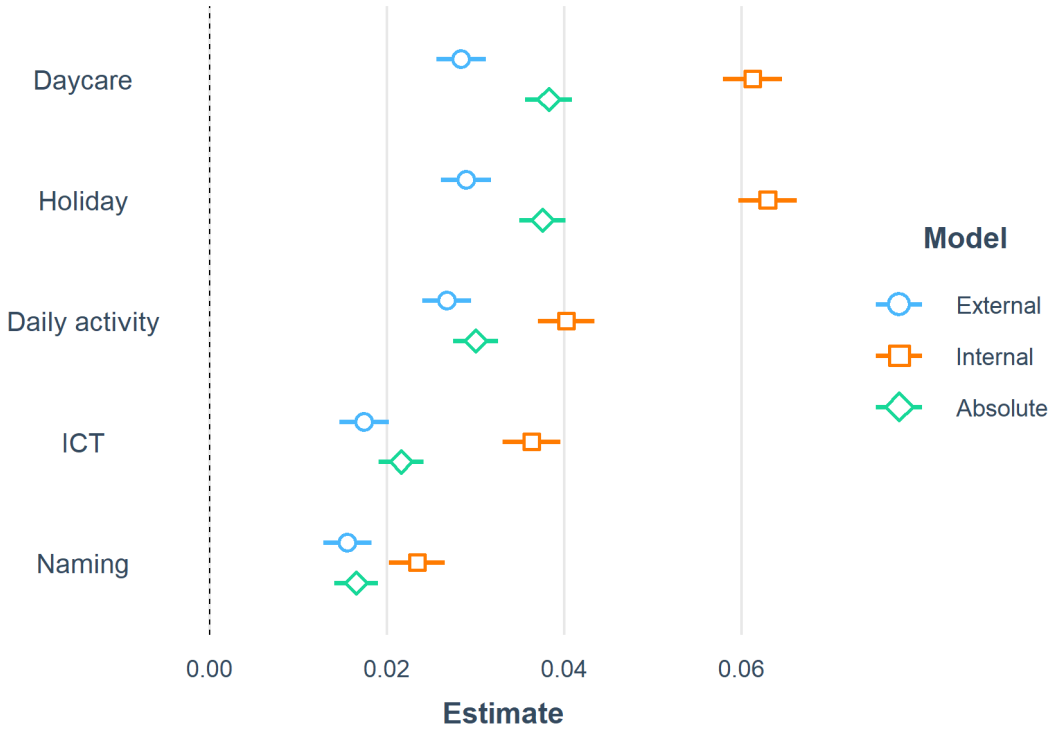

Figure 1. Estimated AMCE.

Note: Each dot shows the point estimator of AMCE, and bars are the 95th confidence interval.

Figure 1 shows two important findings. The main interest attributes are related with combined care service including utilization of daily support, ICT, and naming. All the above have a positive significant impact, which implies that positive demand for combined care services.

Among the combined care service, the daily life supporting has larger AMCE than utilization of ICT and naming. Moreover, effects of the daily life support on the external choice probability is similar size with the AMCE of Daycare and Holiday using.

Subsample analysis

The next figure reports the AMCE in sub-samples. Figure 1 reports the AMCE on whole samples, which is a good summary of preference distribution. However, the figure has no information of the heterogeneous preference, even though the preference for elderly care services.

In the figure, respondents are divided into experience and non-experience groups. The experience group consist of respondents who have engaged care of their parents, while the non-experience group do not have such experience. In the sample, 607 respondents are in the experience group, while 21,393 respondents are in the non-experience group.

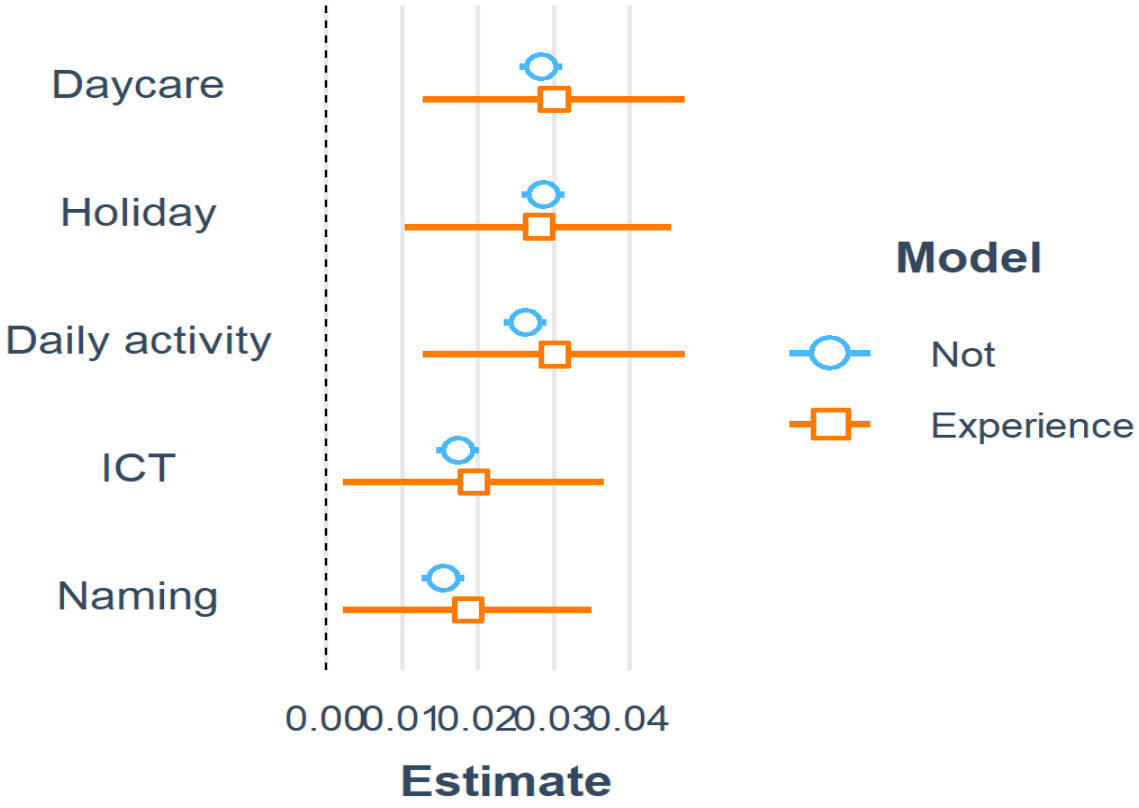

Figure 2. Estimated AMCE in experience and non-experience groups.

Note: Each dot shows the point estimator of AMCE, and bars are the 95th confidence interval.

Figure 2 shows the AMCE on external choice probability. The figure has no clear evidence of heterogeneous preference, even though the point estimators are slightly difference between groups. The result does not imply "homogeneous" preference because a potential reason is large estimation errors of AMCE in the experience group due to sample size problem (607 respondents).

5.2. Welfare analysis

5.2.1. WTP from the internal choice probability

This section reports results of empirical welfare analysis. First, the average willingness-to-pay from internal choice probabilities are here reported because the surplus are most relevant with evaluating service attributes.

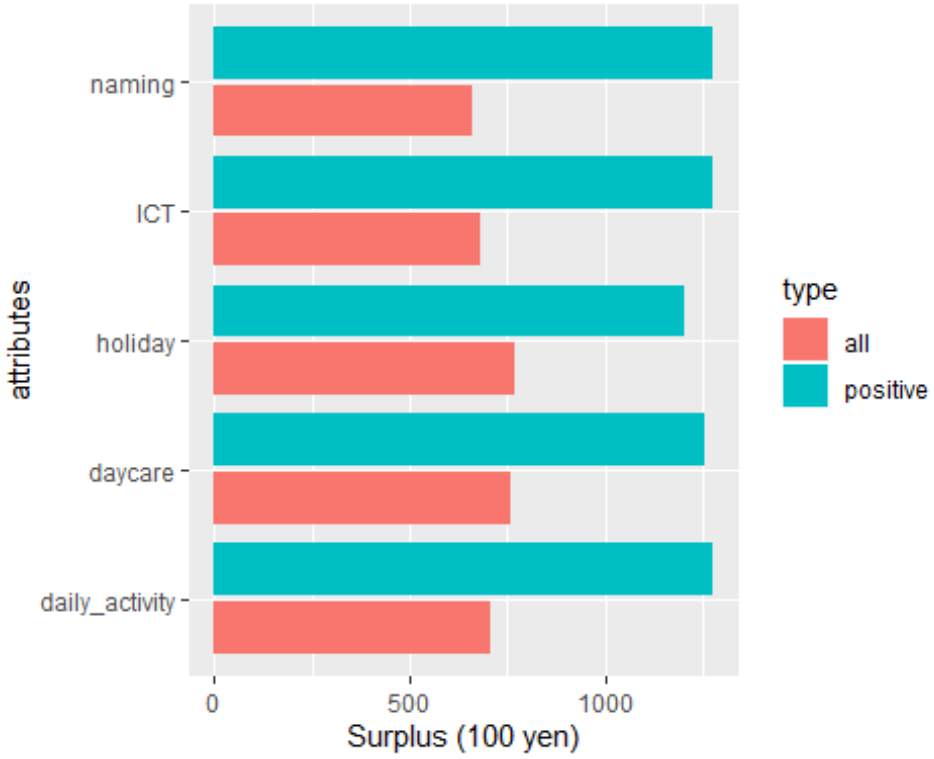

Figure 3. Willingness-to-pay for attributes.

Note: Each bar shows the point estimator of the average willingness-to-pay. The “red” bar is the average WTP in whole samples, while the “blue” bar is in sub-samples with positive WTP.

The figure shows that the willingness-to-pay for “holiday” and “daycare” are larger than other attributes in whole sample. The average willingness-to-pay for those attributes are around 76,000 JPY. Respondents also have high willingness-to-pay for other attributes around 65,000 to 70,000 JPY.

Additionally, the average WTPs are significant;y larger in the positive WTP sub-sample than in the whole sample. The reason is the share of no WTP respondents are large; 40 percents for daycare, 46 percents for holiday care, 45 percents for daily activity, 46 percents for ICT, and 48 percents for naming. Those respondents reduce the average WTP, and the average values are increased if they are excluded.

The large gaps of the average WTP between whole and positive WTP sub-samples imply heterogeneous preferences; while many respondents have no WTP for the attributes, remaining respondents have large WTP. Those heterogeneity is especially large for daily activity, ICT, and naming.

In the Appendix, the estimated surplus from the total and external choice probabilities are shown (Figure A.1 and A.2). Those figures show consistent findings with Figure 3; the large gaps of WTP are still observed.

6. Conclustion

The paper evaluates the relative importance of service attributes in the elderly care markets. We first propose a non-parametric evaluation framework as an extension of Bhattacharya (2015 and 2018). The framework connects the identified causal effects and the surplus changes without parametric assumptions on the utility function.

Our findings show the significant surplus impacts of service attributes which are not covered by the public insurance in Japan. Additionally, the impacts are totally heterogeneous; a part of respondents have

large WTP, while remaining respondents have no WTP. The heterogeneity implies that the additional service should not be free because many respondents have no WTP.

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Appendix. Surplus estimation from the total choice probability

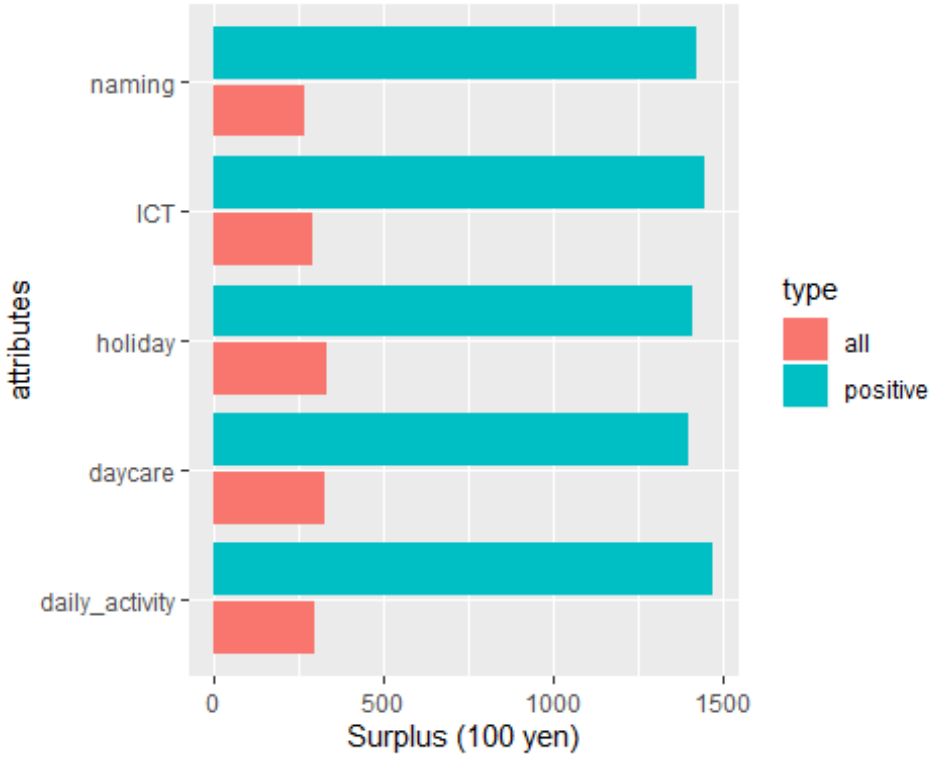

Figure A-1. Willingness-to-pay for attributes.

Note: Each bar shows the point estimator of the average willingness-to-pay. The "red" bar is the average WTP in whole samples, while the "blue" bar is in sub-samples with positive WTP.

Appendix. Surplus estmation from the external choice probability

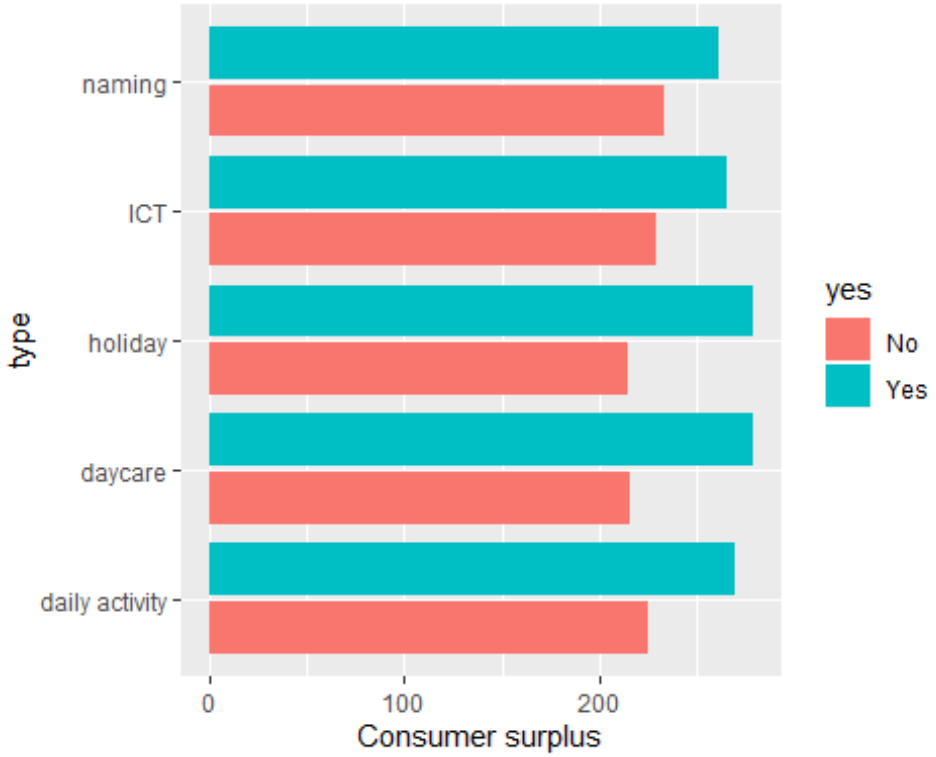

Figure A-2. Estimated surplus from the total choice probability.

Note: Each bar shows the point estimator of the average willingness-to-pay.

Appendix. Identification of surplus distribution from external choice probabilities

The distribution of c is $\Pr[c_i \leq C|a,p]$ for $C > 0$. Because the utility function is increasing of costs, $u_i(a,p+C) \leq u_i(\phi,0)$ if $C >= c_i$ because $u_i(a,p+c_i) = u_i(\phi,0)$. Therefore,

$$\Pr[c \leq C|a,p] = \Pr[u_i(a,p+C) \leq u_i(\phi,0)]$$

$$= 1 - \Pr[u_i(a,p+C) \geq u_i(\phi,0)]$$

$$= 1 - E[Y_i^E(a,p+C)]$$

$$= 1 - E[Y_i^E|a,p+C].$$

Note that

$$\Pr[c = 0|a,p] = \Pr[u_i(a,p) \leq u_i(\phi,0)]$$

$$= 1 - E[Y_i^E(a,p)]$$

$$= 1 - E[Y_i^E|a,p].$$

Appendix. Identification of surplus distribution from internal choice probabilities

The distribution of c is $\Pr[c_i \leq C|a,p,a',p']$ for $C > 0$. $u_i(a,p+C) \leq u_i(a',p)$ if $C >= c_i$ because $u_i(a,p+c_i,a',p) = u_i(a',p)$ and the utility function is increasing of costs. Therefore,

$$\Pr[c \leq C|a,a',p] = \Pr[u_i(a,p+C) \leq u_i(a',p)]$$

$$= 1 - \Pr[u_i(a,p+C) \geq u_i(a',p)]$$

$$= 1 - E[Y_i^I(a,a',p+C)]$$

$$= 1 - E[Y_i^I|a,a',p+C].$$

Note that

$$\Pr[c = 0|a, a', p] = \Pr[u_i(a, p) \leq u_i(a', p)]$$

$$= 1 - E[Y_i^I|a, a', p].$$

Appendix. Identification of surplus distribution from total choice probabilities

The distribution of c is $\Pr[c_i \leq C|a, p, a', p']$ for $C > 0$. $u_i(a, p + C) \leq \max\{u_i(a', p), u_i(\phi, 0)\}$ if $C >= c_i$ because $u_i(a, p + c_i, a', p) = \max\{u_i(a', p), u_i(\phi, 0)\}$ and the utility function is increasing of costs. Therefore,

$$\Pr[c \leq C|a, a', p] = \Pr[u_i(a, p + C) \leq \max\{u_i(a', p), u_i(\phi, 0)\}]$$

$$= 1 - \Pr[u_i(a, p + C) \geq \max\{u_i(a', p), u_i(\phi, 0)\}]$$

$$= 1 - E[Y_i^T(a, a', p + C)]$$

$$= 1 - E[Y_i^T|a, a', p + C].$$

Note that

$$\Pr[c = 0|a, a', p] = \Pr[u_i(a, p) \leq \max\{u_i(a', p), u_i(\phi, 0)\}]$$

$$= 1 - E[Y_i^T|a, a', p].$$