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Valuation of coral reefs by using site choice model

Katsuhito NOHARA, Azusa OKAGAWA, Akira HIBIKI and Hiroya YAMANO

Abstract The coral reef ecosystems provide many goods and services to coastal populations, such as tourism. Furthermore, they form a unique natural ecosystem, with an important biodiversity value as well as scientific and educational value. They also form a natural protection against wave erosion. However, they have been damaged due to red soil erosion and global warming. Therefore, the preservation of coral reefs has been an important policy issue. The cost-benefit analysis is important for choosing cost-effective policies. Although a few studies have evaluated the economic value of coral reefs in Okinawa prefecture, Japan, most of them have applied the contingent valuation method. The purpose of this study is to employ the discrete choice travel cost method to estimate the value of coral reefs that is obtained by visitors to Okinawa prefecture. We conducted an on-site survey of visitors at Naha airport, New Ishigaki airport and Miyako airport on 8 November to 11 in 2013 and collected 410 responses. We applied the conditional logit model to tourist's decision to select his/her destination and estimate the model using collected data. Based on the conditional logit model, the hypothesis of independence from irrelevant alternatives (IIA) cannot be rejected. We also tried to apply the mixed logit model to our data but there was no significant difference between random parameters and nonrandom ones. The main finding is that the marginal willingness to pay by a tourist for coral reefs is 4,754 yen/km^2 per day and 16,544 yen/km^2 per trip.

Key words: *the value of coral reefs, site choice model, marginal willingness to pay*

1. Introduction

Coral reefs in Japan range about 34,700 ha and 80% reef area is within Okinawa prefecture. Coral reefs have important ecosystem functions, including providing habitat to marine life, and maintain those ecosystems. Currently, however, coral reefs in Okinawa tend to decrease every year because of coral reefs bleaching, primarily due to climate-induced ocean warming, feeding damage by acanthaster, runoff of red soil, and so on. The ecosystem services of coral reefs extend to not only the people who live surrounding them but also the visitors of recreation sites in these ranges. Therefore, the decrease of coral reefs would seriously affect the tourism industry.

This study evaluates how the standing crop of coral reefs affects tourist behavior. Visitors of Okinawa choose a site from a finite set of alternatives (all islands in Okinawa) by considering the environmental quality. From this perspective, we apply the discrete choice method and analyze how the standing crop of coral reefs affects tourist behavior. A random utility model (RUM) is used to predict tourist's preferences among a set of alternative sites. After RUM was first applied to

recreational choices by Bockstael et al. (1987)[1], many studies have evaluated the natural value from the economics perspective (see Herriges and Kling (1995)[2], Haab and McConnell (2003)[3]).

The value of nature has use value, which yields benefits by using natural resources directly, and non-use value, which yields benefit by its existence. Since the 1990s, some studies have evaluated ecosystem services of coral reef, for example, Costanza et al. (1997)[4] and Cesar et al. (2003)[5] gave an estimate of the global value of coral reefs. Since the 2000s, many studies have evaluated the value of coral reefs, for example Ahmad et al. (2007)[6] and Ransom and Mangi (2010)[7] have estimated the direct and indirect use value of coral reefs by using the travel cost method (TCM) or contingent valuation method (CVM). Most studies that apply the site choice model to recreation have examined fishing, for example, Morey et al. (1991)[8], Feather et al. (1995)[9], and Berman et al. (1997)[10]. To our knowledge, there are no studies estimating the value of coral reefs using the site choice model. In addition, Laurans et al. (2013)[11] reviewed some papers in detail that estimated the value of coral reefs. On the other hand, in Japan, Oh (2004)[12] has estimated the value of coral reefs in Kerama islands and Tamura (2006)[13] has estimated them around the Akajima sea area. Both have estimated the non-use value of coral reefs focusing on ecosystem services by CVM.

In Japan, in the case of the lost value of coral reefs caused by their decrease, it is important to include not only the non-use value, for example, heritage value and existence value, but also the use value, for example, the indirect use value that generates benefits of snorkeling or diving because of the existence of coral reefs affecting many kinds of fishes. However, as far as we know, previous studies in Japan have focused on only non-use value of coral reefs by using CVM; they have not estimated the value of them as tourist resources. Then, this study analyzes how visitors make decisions of choosing a site, clarifies how the existence of coral reefs attracts visitors, and estimates the benefits by using on-site survey data in Okinawa main island and other isolated islands. Furthermore, using estimated parameters, we analyze how visitors decrease because of decreasing coral reefs using estimated parameters.

2. Methods

2.1 The Choice Modeling Approach for the Economics Valuation

This study estimated the parameters of utility function by using the conditional logit model (CLM) because we consider that each tourist chooses the most desirable site among available alternatives. CLM imposes independence from irrelevant alternatives (IIA) restriction across alternatives. Therefore, this study also estimated the parameters by using mixed logit model (ML). However, as explained in appendix A, this study adopted the parameters estimated by CLM because of three reasons: (1) there is no strong reason applying ML as the hypothesis which variance of the parameters estimated by ML is significantly different from 0 is rejected, (2) IIA restriction was not rejected by the McFaden-Hausman test, (3) the parameters estimated by ML were almost same as the

parameters estimated by CLM.

The utility individual n chooses at site i is

$$U_{ni} = \beta_1 tc_{ni} + \beta_2 days_n reef_i + \beta_3 days_n historic_i + \beta_4 days_n theme_i + \beta_5 days_n nature_i + \beta_6 days_n hotel_i + \gamma_1 income_n + \gamma_2 family_n + \gamma_3 alone_n + \varepsilon_{ni} \quad (1)$$

where

$\beta_k \ (k = 1,2,\cdots 6)$ denotes the parameters about attributes of chosen site i;

$\gamma_l \ (l = 1,2,3)$ denotes the parameters about attributes of individual (subscription i is omitted); and ε_{ni} is random error.

tc_{ni} is the round trip cost from an individual's house to the nearest airport, $reef_i$ is the standing crop of coral reefs, $historic_i$ is the number of historic sites (e.g. Shuri-jo castle and The Tower of lilies), $theme_i$ is the number of sightseeing sites (e.g. The Churaumi Aquarium), $nature_i$ is the number of picturesque scenery (e.g. Manzamou) and $hotel_i$ is the number of resort hotels. This study regards $hotel_i$ as a proxy variable representing landscape of site i because resort hotels are generally located at scenic spots. $income_n$ is the household income, $days_n$ is the visit duration, $family_n$ dummy variable is 1 in case of family trip and 0 otherwise, and $alone_n$ dummy variable is 1 in case of travelling alone and 0 otherwise. In addition, we added cross terms as multiplication between visit duration and standing crop of coral reefs, the number of historic sites, the number of sightseeing sites, the number of picturesque scenery and the number of hotels to the explanation variable because the more visitors stay for a long time, the more their utility increases through their experience. In short, this represents that it is possible for visitors to gain substantial benefit from a variety of activities such as snorkeling and diving because the extent of benefit depends on the length of their stay. Note that this study regards visit duration as an external variable. The reason for this is that most Japanese working people cannot choose their travel schedule flexibly because they take a trip during their limited paid vacation and national holidays.

2.2 Data

The data for this analysis stem from an on-site survey of visitors of Okinawa prefecture in Japan, implemented from 8 November to 11 in 2013 at Naha airport, New Ishigaki airport and Miyako airport. We distributed the questionnaires to visitors who came from other prefectures and could collect 410 responses. In the analysis below, individuals were excluded from the final sample if they did not answer all the necessary questions, if their answer did not meet the conditions specified, if their purpose was not sightseeing but business, or if their choice sets were not sufficient for estimation, and so on. This resulted in 163 individuals being excluded from the sample. The key

question items include: the activities at a visiting site, the number of visitors to Okinawa so far, travel costs, the place of residence, the number of accompanied people, and household income.

It is important to set the choices when using a site choice model. As there were many cases in which only visitors went to some areas and the isolated islands in Okinawa, if visitors went to some sites, this study regarded those combinations as one choice set to analyze briefly and we adopted the combinations that there was much visit frequency. Therefore, for the main island of Okinawa, this study adopted three regions (the northern area of main island of Okinawa, Motobu peninsula and around Naha city), where many tourists visited, and the combinations of these regions. In addition, as Miyako islands include the Miyako-jima Island, Ikema-shima Island, Kuruma-shima Island, Irabu-jima Island, and Shimoji-shima Island, this study regarded them as one choice set. Similarly as Yaeyama islands include Ishigaki-jima Island, Taketomi-jima Island, Kohama-jima island, Iriomote-jima Island, and Yufu-jima Island, this study regarded them as one choice set. From the above, we organized the visit pattern of tourists and adopted eight choice sets ((1) the northern area of main island of Okinawa, (2) around Naha city, (3). Motobu peninsula and the northern area of main island of Okinawa, (4) Motobu peninsula and around Naha city, (5) the northern area of main island of Okinawa and around Naha city, (6) Motobu peninsula, the northern area of main island of Okinawa and around Naha city, (7) Miyako area, and (8) Yaeyama area). The final sample size used in the analysis was 196.

2.3 Travel Costs

The number of standing crops of coral reefs were calculated by multiplying the cover degrees of coral reefs (the cover ratio of coral reefs in the bottom of sea (National Institute for Environmental Studies (2009)[14)]) and the distribution area. The number of tourist resources in each site referred to tourist guidebook (e.g., historic sites, tourists facilities such as theme parks, picturesque sites, resort hotels and so on (see Table.1)).

Travel costs were calculated by adding round trip costs from the nearest public office to the nearest airport and from it to the arrival airport (e.g., Naha airport, New Ishigaki airport and Miyako airport), because it was difficult to get more detailed address. When the respondents used their own car between their house and the nearest airport, the costs were defined as the petrol cost (160 yen per liter) ×fuel consumption (20 km per liter) × distances + highway tolls. The petrol cost referred to The Price Survey of Oil Products published by Agency of Natural Resources and Energy. The calculation of fuel consumption adopted the average cost using The List of Vehicle Fuel Consumption published by Ministry of Land, Infrastructure and Transport. The distances from a respondent's house to the nearest airport were calculated using Google map[15)] and internet site[16)]. When the respondents used rental cars between their house and the nearest airport, the costs were defined as the price of rental car + the petrol cost (160 yen per liter)×fuel consumption (20 km per

Table1

The number of tourist resources in each choice sets

	Historic sites	Tourists facilities	Picturesque sites	Resort hotels	The number of respondents
1.The northern area of main island of Okinawa	3	2	6	28	10
2.Around Naha city	6	5	3	2	14
3.Motobu peninsula and the northern area of main island of Okinawa	4	7	9	32	10
4.Motobu peninsula and around Naha city	7	10	6	6	20
5.The northern area of main island of Okinawa and around Naha city	9	7	9	30	31
6.Motobu peninsula, the northern area of main island of Okinawa and around Naha city	10	12	12	34	59
7.Miyako area	0	0	8	4	10
8.Yaeyama area	0	4	16	15	42

liter)×distances + highway tolls. We assume that the price of rental car is the one-way car rental fee. When the respondents used taxi or public transportation between their house and the nearest airport, the cost was defined by summing up each fee. This study calculated the average round trip fares from the nearest airport and Naha airport, New Ishigaki airport, and Miyako airport by using the lowest fares of 60 days before the departure for each airline company. All cost of the rental car and taxi or public transportation was calculated using tariffs stated online[17)18)].

3. Estimation Results

As mentioned above, this study estimated direct and indirect use value of coral reefs for visitors. All visitors enjoy directly or indirectly the benefits from coral reefs. For instance, there are some tours to see coral reefs and marine species by snorkeling or through glass boat. The utility yielded by seeing coral reefs is a direct effect of coral reefs existence. On the other hand, the existence of coral reefs allows the visitors to gain large utility by seeing marine species. In this case, the utility yielded by seeing marine species is an indirect effect of coral reefs existence. In addition, as the coastal

Table2

Estimation Results

Explanatory variables	Model 1	Model 2	Model 3	Model 4
tc_{ni}	-0.00012*	-0.00015**	-0.00012*	-0.00012*
$days_n reef$	0.57042**	0.59259**	0.56882**	0.56220**
$days_n historic_i$	0.17562***	0.17903***	0.17557***	0.17516***
$days_n theme_i$	0.03431	0.03354	0.03432	0.03399
$days_n nature_i$	-0.30920*	-0.31430*	-0.30920*	-0.03399
$days_n hotel_i$	0.02532	0.02558	0.02532	0.02521
$days_n reef \cdot d_{child}$		-0.0878**		
$days_n reef \cdot d_{aged}$		-0.02489*		
$days_n reef \cdot d_{marine}$			0.00185	
$days_n reef \cdot d_{snorkeling}$				0.00905
Choice set 1				
$income_n$	-0.00178	-0.00109	-0.00101	-0.001
d_{family}	1.86660*	2.04199*	1.86712*	1.86412*
d_{alone}	-15.88	-15.1157	-15.8807	-14.8337
Choice set 3				
$income_n$	-0.00177	-0.00187	-0.00178	-0.00177
d_{family}	1.26268	1.52016	1.26355	1.26904
d_{alone}	-16.0695	-15.3077	-16.0702	-15.0168
Choice set 4				
$income_n$	-0.00058	-0.00063	-0.00058	-0.00057
d_{family}	0.88035	1.01511	0.8816	0.88199
d_{alone}	-2.39438**	-2.3906**	-2.39396**	-2.38949**
Choice set 5				
$income_n$	-0.00033	-0.0004	-0.00033	-0.00033
d_{family}	0.21616	0.37247	0.21743	0.21758
d_{alone}	-1.3528*	-1.36162*	-1.35241*	-1.34615*
Choice set 6				
$income_n$	-0.00095	-0.00104	-0.00096	-0.00095
d_{family}	0.50505	0.75876	0.50646	0.51062
d_{alone}	-2.62299***	-2.63889***	-2.62217***	-2.60249***
Choice set 7				
$income_n$	-0.00303*	-0.003*	-0.00302*	-0.00306*
d_{family}	-0.35491	0.048	-0.35299	-0.33456
d_{alone}	-16.6155	-15.8526	-16.6134	-15.5653
Choice set 8				
$income_n$	-0.00049	-0.00059	-0.00048	-0.00054
d_{family}	0.48862	0.99812	0.49045	0.51649
d_{alone}	-1.7563**	-1.90406**	-1.7545**	-1.7382**
Number of obs	1568	1568	1568	1568
Number of cases	196	196	196	196
Log likelihood	-340.516	-334.838	-340.511	-340.236

Note: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

scenery in Okinawa is mostly derived from coral reefs, the utility yielded from that is also an indirect effect of coral reefs origin (see Cesar et al. (2004)[19] and UNEP-WCMC(2006)[20] for more details about the indirect use of coral reefs).

This study regarded the choice set of Around Naha city as the base category. To confirm the robustness of estimation, in addition to equation (1), the model including the variable of the number of accompanied people and the model including the cross terms multiplying visit duration and interest in natural resources were estimated. The estimation results are shown in Table. 2. d_{child} and d_{aged} are dummy variables expressing visitors accompanied children or aged persons, d_{marine} is dummy variable expressing whether visitors were interested in marine species, $d_{snorkeling}$ is dummy variable expressing whether visitors experienced activities, and d_{family} and d_{alone} are dummy variables expressing whether visitors traveled with family or alone. Choice set numbers in Table 2 correspond to the area that the visitors chose in Table 1.

The sign of the coefficient of TC is negative. This negative correlation between the number of trips and costs conforms to economic theory, and satisfies the sign conditions. The sign of the coefficient of the cross term about visit duration and standing crops of coral reefs is positive and significant at 5%. This means that the longer the visitors stay, the more they can enjoy utility by coral reefs. This also means that even if the visitors' visit duration is the same, the more the area of coral reefs expands, the larger is the visitors' utility. This interpretation also applies to the coefficient of cross term about visit duration and the number of historic sites. The coefficient of cross term about visit duration, the number of tourists facilities and about visit duration, and the number of resort hotels are not significant. Furthermore, the coefficient of cross term about visit duration and the number of picturesque sites is negative and significant at 10%. The result is contrary to initial expectation. In Model 2, we added the cross term about visit duration, the area of coral reefs and the dummy variable about age of accompanied persons to Model 1, and both coefficients are negative and significant. This means that their utility decreases when visitors accompany children below elementary school age or aged persons if they can enjoy a lot of standing crops of coral reefs during their visitation. This is because the aged avoid snorkeling or diving because of their high-risk nature.

Further, we estimated Model 3 and Model 4 because the visitors who were interested in directly experiencing the coral reefs, because of previous experience in snorkeling or a high interest in marine species, would value them highly. However, those coefficients were not significant (Table 2).

The marginal willingness to pay for the area of the coral reefs per day can be obtained from equation (2).

$$MWTP = -\frac{dV}{d\left(days * reef\right)} \Big/ \frac{dV}{dtc} = -\frac{\beta_2}{\beta_1} \tag{2}$$

Table 3

The value of coral reefs for all visitors to Okinawa per year

	The standing crops of coral reefs （㎢）	The number of visitors	The value of coral reefs for visitors per year (billion yen)
Yaeyama area	10.186	742,092	125.1
Miyako-jima Island	6.65	413,654	45.6
Kume-jima Island	0.323	83,094	0.44403

The marginal willingness to pay for the area of the coral reefs per day by using the results of Model 1 is 4,754 yen/㎢. This can be interpreted as a visitor paying 4,754 yen to increase the area of the coral reefs for each additional day's stay. In addition, regarding the estimated value of the marginal willingness to pay, we estimated the 90% confidence interval by 10,000 time's Monte Carlo simulation. The estimated value was from 222 yen to 16,695 yen. The average visit duration of respondents was 3.48 days. We calculated the average marginal willingness to pay by a visitor per a trip as 16,544 yen/㎢ by multiplying the average duration of respondents (90% confidence interval was between 772 yen and 58,098 yen). For example, as the standing crops of coral reefs in Aka-jima Island are 0.24㎢ and the number of visitors in 2011 are 33,934, the direct and indirect use values of the coral reefs around Aka-jima Islands became about 134.74 million yen per year under our estimation results of Model 1. Similarly, as the standing crops of coral reefs in Zamami-son are 0.38㎢ and the number of visitors in 2011 are 71,143 (The Okinawa prefectural government[20]), the direct and indirect use values of the coral reefs in Zamamison became about 447.26 million yen per year. On the other hand, Tamura (2006)[13] estimated the non-use value of the coral reefs in Aka-jima Island and that in Zamamison as about 70 million yen and 200 million yen respectively, and thus, our result is expensive compared to that result. Our result indicates that the use value of coral reefs is larger than their non-use value.

Furthermore, we estimated the direct and indirect use values of coral reefs for visitors per year by using our results of Model 1 and the data of standing crops of coral reefs in Yaeyama area, Miyako-jima area and Kume-jima Island. Then, we used the data of the number of visitors in those areas per year written in Sightseeing Handbook in Okinawa (2012)[21] and the average visit duration (3.48 days) to estimate those values. Those results are shown in Table 3.

Finally, we simulated the effect of changes area in coral reefs on choice behavior of all visitors to Okinawa by using our estimated coefficient of $days_n reef$. In short, if a typical visitor chooses a site i , indirect utility function U_i is

$$U_i = \beta_2 days * reef_i + \alpha_i + \varepsilon_i , \tag{3}$$

Table 4

The changes of the site choice probability in the case of Miyako-jima Island (2012)

The changed area of coral reefs in Miyako-jima Island	-10%	-5%	0
The main island of Okinawa	82.3%	80.7%	77.6%
Yaeyama area	14.2%	13.9%	13.4%
Miyako-jima Island	1.9%	3.8%	7.5%
Kume-jima Island	1.6%	1.6%	1.5%

where α_i is a constant expressing the specific effect of site i and ε_i is an unobserved component. Assuming that the unobserved component ε_i of utility is identically and independently distributed with an extreme value type I distribution, this probability can be expressed as

$$P_i = \frac{\exp(\beta_2 days * reef_i + \alpha_i)}{\sum_{k=1} \exp(\beta_2 days * reef_k + \alpha_k)}. \quad (4)$$

We used the data from Sightseeing Handbook in Okinawa (2012)[21] about the number of visitors per year in each site (Yaeyama area, Miyako-jima Island and Kume-jima Island). We assumed that the number of visitors per year in the main island of Okinawa defined as the value minus the number of visitors per year in each site from all visitors in Okinawa because the number of visitors per year in main island of Okinawa was unknown. We also assumed that the visit duration was 3.75 days as in Sightseeing Handbook in Okinawa (2012)[21]. Assuming that available sites were Yaeyama Islands, Miyako-jima Island, Kume-jima Island, and the main island of Okinawa and the choice probability was the ratio of the number of visitors in each site to all visitors in Okinawa, we estimated that α_i satisfies equation (3) by calibration using our result of Model 1. We simulated how the site choice probability changed by using equation (3) if the standing crops of coral reefs in site i changed. Table 4 shows the result of this if the standing crops of coral reefs in Miyako-jima Island are decreased by 5% and 10%. The value of 0 indicates *status quo* and this value is the actual ratio of visitors. Similarly, Table 5 is the result of simulation in the case of degreasing the standing crops of coral reefs in Yaeyama area. Table 4 reports that the site choice probability of all areas except for Miyako-jima Island increases if only the standing crops of coral reefs in Miyako-jima Island are decreased. Table 5 also reports that the site choice probability of all areas except for Yaeyama area increases. However, the degree of the rate of increase of the site choice probability is not the same. Because the area of coral reefs in Yaeyama is 1.5 times compared to Miyako-jima Island, even if the rate of decrease in area is same, the decreased area of coral reefs in Yaeyama is larger. Therefore, the decrease of area of the coral reefs in Yaeyama has a great effect on decision making of visitors. In addition, the decrease of coral reefs in Yaeyama area and Miyako-jima Island raises the visiting ratio

Table 5

The changes of the site choice probability in the case of Yaeyama area (2012)

The changed area of coral reefs in Yaeyama area	-10%	-5%	0
The main island of Okinawa	88.1%	85.2%	77.6%
Yaeyama area	1.7%	4.9%	13.4%
Miyako-jima Island	8.5%	8.2%	7.5%
Kume-jima Island	1.7%	1.6%	1.5%

of main island of Okinawa. This implies that most visitors change their destination from each isolated island to the main island of Okinawa if coral reefs in Yaeyama and Miyako-jima Island are decreased.

4. Concluding Remarks

In our study, we analyzed how the decrease of coral reefs affected visitor's decision making of site choice by using the data of questionnaire survey conducted at Naha airport, New Ishigaki airport, and Miyako airport. Therefore, we found that marginal willingness to pay by a tourist for coral reefs is 4,754 yen/km^2 per day and16,544 yen/km^2 per trip. Further, by using this result, we found that the value of coral reefs per year for all visitors is 125.1 billion yen in Yaeyama area, 45.6 billion yen in Miyako-jima Island, and 444.03 million yen in Kume-jima Island. Compared to previous studies, the use value of coral reefs for visitors is larger than their non-use value.

Finally, we suggest some topics for future studies. We should estimate all site choice sets including the exempted areas in this study. Furthermore, we should consider the environmental quality by including not only standing crops of coral reefs but also water quality or biodiversity of marine species. In addition, it is important to conduct questionnaire surveys in other seasons and compare to those results to ours.

Appendix

In this study, we estimated the parameters by using mixed logit model with all variables as random except for $income_n$, $family_n$ and $alone_n$ under the assumption that there is no correlation between each variable. However, the estimated result has not converged. Therefore, we divided the combinations of variables and estimated the parameters in each case using mixed logit model. The combinations of variables are as follows:

1) tc_{ni} only at random
2) tc_{ni} and $days_n reef$ at random
3) tc_{ni} , $days_n reef$, and $days_n nature_i$ at random

4) tc_{ni} , $days_n reef$, $days_n nature_i$, and $days_n historic_i$ at random

5) tc_{ni} , $days_n reef$, $days_n nature_i$, $days_n historic_i$, and $days_n theme_i$ at random.

The result is shown in Table A1. The estimated parameters between random and nonrandom are not different from each other. Furthermore, as shown in Table A2, the standard deviation of the parameters in the case of random and nonrandom is not significantly different from 0. Regarding cases 4) and 5), the estimated parameters are different between random and nonrandom; however, the standard deviation of the parameters in the case of random and nonrandom is not significantly different from 0. Therefore, we determined that there is no superiority of using a mixed logit and used CL to estimate parameters. In addition, IIA assumption is satisfied in our study because this assumption could not be rejected by the Hausman-McFadden test.

Table A1

Comparison of the parameters in cases 1)-3)

1)

	nonrandom	random
daysreef	0.5703562	0.5704044
dayshistoric	0.1756042	0.1756113
daystheme	0.0343022	0.0343091
daysnature	−0.3091631	−0.309178
dayshotel	0.025315	0.0253133
income2	0.0010052	0.0010049
income3	−0.0007682	−0.000768
income4	0.0004237	0.0004235
income5	0.0006732	0.0006734
income6	0.0000512	0.0000511
income7	−0.0020211	−0.002021
income8	0.0005175	0.0005175
family2	−1.866313	−1.866481
family3	−0.6037009	−0.603944
family4	−0.9859274	−0.986253
family5	−1.650207	−1.650414
family6	−1.361293	−1.361565
family7	−2.221102	−2.221371
family8	−1.377674	−1.378096
alone2	15.29354	19.16316
alone3	−0.6454834	−0.480892
alone4	12.89975	16.76905
alone5	13.94117	17.81071
alone6	12.67117	16.54051
alone7	−1.143468	−1.034562
alone8	13.53778	17.40743
tc	−0.0001244	−0.000125

2)

	nonrandom	random
dayshistoric	0.1756042	0.17617
daystheme	0.0343022	0.035067
daysnature	−0.309163	−0.31239
dayshotel	0.025315	0.025625
income2	0.0010052	0.001003
income3	−0.000768	−0.00077
income4	0.0004237	0.000422
income5	0.0006732	0.000675
income6	0.0000512	0.000051
income7	−0.002021	−0.00201
income8	0.0005175	0.000521
family2	−1.866313	−1.86477
family3	−0.603701	−0.60576
family4	−0.985927	−0.98761
family5	−1.650207	−1.64787
family6	−1.361293	−1.36086
family7	−2.221102	−2.2231
family8	−1.377674	−1.38577
alone2	15.29354	21.27552
alone3	−0.645483	−0.90222
alone4	12.89975	18.87764
alone5	13.94117	19.91879
alone6	12.67117	18.63656
alone7	−1.143468	−1.47118
alone8	13.53778	19.51995
tc	−0.000124	−0.00013
daysreef	0.5703562	0.575139

3)

	nonrandom	random
dayshistoric	0.1756042	0.1764589
daystheme	0.0343022	0.0351729
dayshotel	0.025315	0.0257279
income2	0.0010052	0.0010029
income3	−0.000768	−0.000772
income4	0.0004237	0.0004236
income5	0.0006732	0.0006764
income6	0.0000512	0.0000508
income7	−0.002021	−0.002014
income8	0.0005175	0.0005221
family2	−1.866313	−1.865198
family3	−0.603701	−0.605645
family4	−0.985927	−0.986556
family5	−1.650207	−1.647636
family6	−1.361293	−1.361879
family7	−2.221102	−2.223492
family8	−1.377674	−1.386422
alone2	15.29354	18.94552
alone3	−0.645483	−0.976074
alone4	12.89975	16.54727
alone5	13.94117	17.58647
alone6	12.67117	16.30331
alone7	−1.143468	−1.033704
alone8	13.53778	17.18556
tc	−0.000124	−0.000127
daysreef	0.5703562	0.5763945
daysnature	−0.309163	−0.31317

Table A2

The results of F-test in case 1)-5)

	Variable	Coefficient	S.E.	P-value
1)	tc	5.85E-06	0.000135	0.965
2)	tc	9.79E-06	0.0001338	0.942
	daysreef	0.0096472	0.0371403	0.795
3)	tc	8.83E-06	0.000134	0.947
	daysreef	0.0086787	0.0447409	0.846
	daysnature	0.0047696	0.0524286	0.928
4)	tc	-0.0008087	0.0007137	0.257
	daysreef	-0.0215683	0.0649769	0.74
	dayshistoric	0.1068052	0.0799751	0.182
	daysnature	-0.0018986	0.0287859	0.947
5)	tc	0.0003571	0.0003268	0.275
	daysreef	0.0343454	0.0562381	0.541
	dayshistoric	0.0730182	0.0687465	0.288
	daysnature	-0.0094318	0.0293028	0.748
	daystheme	0.0391075	0.0411464	0.342

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