Public Preferences for Crime Risk Reduction in Japan: Evidence from stated preference data

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Abstract

We conducted a contingent valuation method (CVM) for averting burglary and homicide, and choice experiments (CE) on residential general crime risk. We investigated several topics: Willingness to pay (WTP) for the personal reduction of burglary and homicide risk; public preferences for general crime risk reduction; and the influence of intangible/tangible covariates on preferences for crime risk reduction.

By using the CVM, we estimated the WTP for reducing burglary risk at 1/10,000 to be 15,580 yen. On the other hand, 12,877 yen is the WTP for reducing homicide risk at 1/1,000,000. This suggests that the number of family members affects the WTP for reducing burglary risk, while household income per capita affects that for reducing homicide risk. From the CE result, the marginal WTP for general crime risk reduction at 1/100,000 population is 181 yen per respondent, with the suggestion that income level and attitudes toward police influence the marginal WTP.

Above all, we put forth some avenues for future economic research on crime-risk averting behavior, especially in Japan.

***Keywords**: Burglary, Homicide, General Crime Risk, Contingent Valuation Method, Choice Experiment*

1. Introduction

The popular consensus is that community safety has deteriorated all over Japan and that the number of perceived offences has been increasing (see e.g. Kusago (2007)). The perceived cases and the crime rate have reached approximately 2.9 million, which is calculated by the number of perceived offences per 100,000 population having reached 2239.4 during 2002, around the time of our survey. The crime rate in Tokyo, the capital and one of the greatest cities in Japan, was calculated at 2470.9 - 7th place in the country - during

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2002[1].

According to the Metropolitan Police Department, the total number of crimes in Tokyo appears to be recently decreasing,[2] suggesting that the police department, nongovernmental organizations, and/or community volunteers have been functioning well. Indeed, Yamamura (2009) suggested that police and social capital have been effective deterrents of larceny in Japan. On the other hand, burglary and non-burglary offenses represent a larger proportion of overall crime than homicide. The number of perceived burglary cases was approximately 23,182 in 2002, while that of perceived homicide cases was 92, a much smaller frequency than burglary. Indeed, Hiraiwa-Hasegawa (2005) reported that the crime rate for homicide decreased during the 20th century in Japan, which she theorized was driven by age pattern cohorts.

The fear of homicide seems to arise in dark areas, solitary places, etc. Yokohari et al. (2006), for example, reported on the fear of crime in new towns in Japan. The fear of crime can be considered an intangible cost of crime. We should consider not only the tangible costs of crime, but also the intangible costs. This, for example, enables us to conduct a cost benefit analysis in order to investigate efficient and effective crime risk management (cf. Dolan et al. (2005)). Moreover, it is necessary to clarify the extent to which public and private sectors play roles in crime risk reduction.

It is therefore necessary to determine how we can make crime risk management effective with regard to the preferences of residents for crimes of both large and small frequency, especially in Japan. Moreover, we should investigate how much the public is willing to pay for private countermeasures and how this is affected when taking intangible/tangible covariates, such as demographics or psychological attitudes, into account. In our review of recent studies on the economic evaluation of crime risk, we identified three questions worth investigating: 1) What is the Japanese preference for averting behavior of particular crime risks when elicited by the utilization of familiar private goods; 2) How does crime risk affect residential choice; and 3) What and how intangible/tangible covariates influence the public preference for crime risk reduction? Through this investigation, it will be possible to see whether and how much members of the public are willing to privately pay for countermeasures, and how that willingness is affected by intangible/tangible covariates. This will then enable us to consider effective crime risk management.

To tackle these topics, we decided to adopt several methods: We employed 1) Two formats of a double bound (DB) dichotomous choice contingent valuation method

1 Indeed, we showed these figures to the respondents in the main survey, as summarized subsequently in this article.

2 Metropolitan Police Department (URL: http://www.keishicho.metro.tokyo.jp/anzen/sub5.htm).

(CVM) on particular purchasing behaviors for averting crimes to mimic real situations and incorporated various covariates into this estimation; 2) Choice experiments (CE) to elicit residential behavior explicitly including general crime rates in the neighborhood, which also mimics real situations, while considering a preference for heterogeneity; and 3) The incorporation of various covariates into the estimation in order to investigate the influence of preferences on crime risk reduction. By these methods, we can overcome the remaining issues of previous studies on crime risks reduction: 1) Particular kinds of purchasing behavior enable us to see how a member of the public is willing to privately pay for countermeasures. This enables respondents to easily understand the designed scenarios in the DB CVM questions. This will lead to the alleviation of hypothetical biases and/or altruism associated with evaluation practices that employ public or unfamiliar goods as the evaluated objectives; 2) The residential CE will serve as the alternate method for hedonic price models to highlight the impacts of crime risk on residential choice, which is encouraged by Luce et al. (2000) observing the trade-off structure between flat rent and security level in laboratory experiments; and 3) When incorporating intangible/tangible covariates into the estimation of the CVM, we can observe the effectiveness of these covariates in averting particular crime risks. In analyzing CE, we adopted two econometric models: First, a random parameter logit model (RPL) in order to investigate the overall structure of the preference heterogeneity; and second, a latent class model (LCM) in order to clarify the determinants of the heterogeneous preferences in detail by incorporating intangible/tangible covariates explicitly into the estimation process. With the above approaches, we can provide certain avenues for future economic research on crime risk management or community safety, especially in Japan.

This article proceeds as follows: In Section 2, we briefly present a literature review of economic studies of crime risks. We provide information on our survey design and obtained residential characteristics in Section 3. The econometric methods are presented in Section 4. The results are then provided in Section 5 followed by detailed discussion, conclusion, and topics for future research in Section 6.

2. Literature Review on Economic Studies of Crime Risk

According to Freeman (2003), a cost of illness approach, which can be practically employed as a method for a lower bound of welfare measures, is theoretically a part of observable expenditure in an averting behavior approach[3]. The term "cost of illness" is frequently referred to only as "the social cost of lost earnings plus the medical expenditures

3 McCollister and French (2003) provide a comprehensive review of previous studies employing a cost of illness approach.

associated with illness" (Freeman (2003); p.331, ll.12-14) - only tangible costs. Thus, it should be noted that the cost of illness, or averting *expenditure* approach as a whole, fails to capture intangible costs or costs that are hard to estimate due to data availability, such as fear or "the cost of lost leisure" (Freeman (2003); p.331, ll.15-16) - the opportunity cost of illness. A cost of illness approach can also be justified by tacitly assuming that "individuals correctly perceive the effects of their actions" (Freeman (2003); p.338, l.2) - perfect information on every outcome of averting *behavior*.

Recent studies also support Freeman (2003). Thavorncharoensap et al. (2009) summarized publications on the cost of alcohol consumption, finding that few studies include intangible costs and most of these studies had employed previous results of a stated preference approach. Indeed, Jarl et al. (2008), who is one of them, utilized certain results from the CVM to estimate the intangible cost of crime - a utilization of benefits transfer. Furthermore, most of the previous studies do not address crime-specific costs, which is a prerequisite for political decision making on crime risk management. However, McCollister et al. (2010) employed costs of illness as tangible estimates and jury compensation as intangible ones. When it comes to welfare estimates or preferences for crime risk reduction, a cost of illness approach or an averting *expenditure* approach as a whole may be less appealing to decision makers. Thus, we should find other application approaches for Japan.

Since Thaler (1978), a hedonic price approach has been employed for investigating the relationship between residential location and crime risk. Linden and Rockoff (2008) suggest that United States residents find it undesirable to have convicted sex offenders live in their neighborhood, which has a negative impact on house values. Kutsuzawa et al. (2007) adopted a hedonic price approach in Japan, utilizing cross section data and admitting that it is appropriate to employ panel data. Such data is of comparatively short availability in Japan. The same situation exists in the purchasing behavior of certain countermeasures: In Japan, we rarely record either the cross section or panel data of any purchasing behavior. In addition, it remains a question in Japan whether residents choose their house locations with reference to the perceived crime risks, though Kutsuzawa et al. (2007) tried to clarify this issue. Though a hedonic price approach is a proven effective method for averting behavior of crime risk, we in Japan should employ another approach; it should be a stated preference method, such as CVM or CE.

There are also cumulative studies that employ CVM in order to estimate preferences for crime risk reduction. Ludwig and Cook (2001) first proposed an ex ante evaluation of risk of victimization by using CVM in the US. Cohen et al. (2004) used a single bound dichotomous choice CVM on crime risk management in the US. Atkinson et al. (2005) provided thorough procedures of CVM for evaluating several violent crimes: Common assault; other (moderate) wounding; and serious wounding in the UK. Piquero and Steinberg

(2010) explored public preferences for treating juvenile offenders through DB CVM in the US. These previous studies of CVM are summarized in Table 1. Most of these studies prove the influence of various covariates. CVM has been frequently employed when estimating the benefits of particular types of crime risk reduction or some political program for crime risk management. On the other hand, to our knowledge, no studies have used the private purchase of countermeasures for crime risk to capture averting *behavior*.

Table 1: Previous Studies on Crime Risk CVM

	Objective	Payment Vehicle	Type of Crime	Estimate	Currency	Reduction	Affected Agents
Ludwig and Cook (2001)	Gun Reduction Program	Tax	Gun Assault	239	USD	30%	102.5 million Households
Cohen et al. (2004)	Crime Prevention Program	Payment for Community	Burglary	104	USD	10%	103 million Households
			Armed Robbery	110	USD	10%	103 million Households
			Serious Assault	121	USD	10%	103 million Households
			Rape and Sexual Assault	126	USD	10%	103 million Households
			Murder	146		10%	103 million Households
Piquero and Steinberg (2010)	Rehabilitation Program on Youth Crime	Tax	Rehabilitation	94.186~ 102.281	USD	30%	10,000 youth offenders
			Incarceration	73.106~ 98.392	USD	30%	
Atkinson et al. (2005)	Law Enforcement	Local Charge	Common Assault	5,282	GBP	statistical 1 case	Not Presented in Original Paper
			Other Wounding	30,908	GBP	statistical 1 case	Not Presented in Original Paper
			Serious Wounding	35,884	GBP	statistical 1 case	Not Presented in Original Paper
Zarkin et al. (2000)	Drug Abuse Treatment	Payment for Program	Drug Abuse	37.12	USD	100 users	0.9 million households
				30.9	USD	500 users	0.9 million households
Tang et al. (2007)	Drug Abuse Treatment	Payment for Program	Drug Abuse	81.00~ 95.00	TWD	1,000 or 5,000 patients	13 million people insured in the program

As for CE, Ibanez and Carlsson (2010) conducted CE on the reduction of cocaine production in Colombia. The study consisted of a choice set that varied the profit of the coca plant or an alternative crop and the probability that the coca cultivation farm lands would be detected and destroyed by the authorities. In addition, they simultaneously implemented risk experiments in order to capture attitudes towards the financial risk of having the crops destroyed by the authorities. One of their findings is that certain non-monetary factors influence the preference structure, for example, religion, and the acceptance of law and the authorities. Luce et al. (2000) proved the trade-off structure between flat rent and security level with laboratory experiments. Their study suggested that CE works on crime risk well enough to capture anti-social behavior and that intangible/tangible covariates are quite

important in accordance with Ibanez and Carlsson (2010). In addition, CE may work better when designed as a choice of a rental flat with reference to Luce et al. (2000), which covers the data availability of hedonic prices. However, no CE studies have proved the private averting *behavior* of crime risk with a multi-attribute trade-off structure.

Above all, previous studies have proved certain benefits of crime risk reduction and some effects of intangible/tangible covariates on the willingness to pay (WTP). It seems realistic that we in Japan should conduct stated preference surveys. Previous studies have adopted CVM to estimate WTP for a particular crime risk. What the CE studies have proved is that it is very important to collect the intangible/tangible covariates on anti-social behavior and incorporate them into the estimation procedures. In addition, when designing CE as rental flat choices, this may cover the data availability of hedonic prices. However, no studies capture the behavioral features of privately averting crime risks.

We therefore identified several questions worth investigating: 1) What is the Japanese preference for averting behavior of particular crime risks if elicited by the utilization of familiar private goods; 2) How does crime risk affect residential choice, and 3) What and how do intangible/tangible covariates influence the public preference for crime risk reduction? To investigate these issues, we decided to utilize a mail survey. When the results were obtained, we would be able to see whether members of the public are willing to pay privately for countermeasures and how that willingness is affected by intangible/tangible covariates. This would then enable us to consider effective crime risk management.

We used DB CVM for particular kinds of crime with reference to previous studies, such as Cohen et al. (2004). We then employed residential CE to investigate the public preference for crime risk. In the next section, we illustrate our survey design in detail.

3. Survey Design

Before conducting the main survey, we organized preliminary group interviews consisting of graduate school students at Takasaki City University of Economics in order to collect basic information on averting behavior of crime and experiences of victimization. We then obtained opinions that suggested that we should specifically identify the type of crime as there may be differences when stating WTP for a variety of crime reduction. In addition, we identified five attributes of major concern with the location of a rental flat; specifically, walking distance from a station, the presence of neighborhood parks and neighborhood convenience stores, the general residential crime rate, and changes in rental costs. Thus, we decided to investigate several concerns of crime risk: Particular crime risks, specifically, burglary and homicide, for which we applied DB CVM, and a general residential crime risk, for which we employed CE.

The main survey was conducted in May of 2004 by mail. We sent our questionnaire to residents in Tokyo randomly sampled from the phone database. The total number of questionnaires sent was 2,500, including 146 determined to be invalid because of unidentified addresses. Thus, our final sample size was 2,354. We waited one month with one reminder for each sample and then ultimately collected 669 responses (28.4%~669/2,354*100). According to the demographics in Table 2, the sample characteristics of our survey were closely similar to those of the general population except for gender. Although our sampling appears to be ineffective, especially with reference to gender, we tried to estimate models with various covariates in order to alleviate the ineffectiveness. We then were able to obtain 431 effective respondents (18.3%) who fully answered the DB CVM questions, with 120 (5.1%) who answered the CE questions.

As an introduction, we asked questions about the respondent's victimization experiences and concerns, and presented related information from social security for Tokyo in 2002: 1) The number of reported crimes exceeded 0.3 million; 2) The crime rate in Tokyo was 2470.9 per 0.1 million population, which was seventh place in Japan (first place was Osaka at 3408.1); 3) Theft accounted for approximately 80% of total crimes, which included burglary at 12% and non-burglary thefts at 67%; and 4) Homicide accounted for a relatively small percentage of total crime. We also asked whether the respondents performed countermeasures, such as locking doors, antilock-picking procedures, carrying portable alarms or tear-gas spray, having a close-circuit television in their home, and so on. To identify attitudes toward burglary and homicide, we used Likert scale formats, which utilize ten discrete response forms ranging from 1 (strongly disagree) to 10 (strongly agree) on seven items.

Table 2: Demographic Statistics

Item	Mean	S.D.	z test
Age: N=652	59.793	12.489	0.000
Annual Household Income (million yen): N=629	6.845	3.827	0.000
No. of Family Members: N=662	2.378	1.282	0.399
Item	Sub Items	Answers	%
Living with Children 15 Years Old and Under	With	111	16.6
	Without	558	83.4
Gender	Male	535	80.0
	Female	132	19.7
	No answer	2	0.3
Experience of Crime Victims	I have reported/not reported	279	41.7
	I don’t have either.	380	56.8
	No answer	10	1.5
Anxiety of Being Victimized	Frequently	36	5.4
	Sometimes	270	40.4
	Not so much	263	39.3
	Not at all	95	14.3
	No answer	5	0.7

Table 2 (cont'd)

Item	Sub Items	Answers	%
Risk of Crime of My Own.	I deal with it.	395	59.0
	I don't deal with it.	257	38.4
	No answer	17	2.5
Countermeasure of Crime Risk (Multi-answer)	portable security goods	31	
	replacement of keys	227	
	facilities such as CCTV	17	
	have contract with security company	14	
	have safety deposit box	100	
	diversifying my properties	80	
	avoids walking at night	140	
	Others	60	

Note: Annual household income includes pension and tax. Z test is implemented with statistics of general population.

The questionnaire contained an explanation of individual crime rates with visual aids for the first CVM question on burglary (see Appendix), for which we subsequently provided the required countermeasures. We chose the private goods in a manner that alleviated hypothetical biases or altruism: Specifically, 1) A high spec security lock to successfully reduce the risk of burglary for 1/10,000 in the subsequent year; and 2) A portable alarm to successfully reduce the risk of homicide at 1/1,000,000 in the subsequent year. Both of these items are familiar to the general Japanese population. The extent of reduction for both was set to reflect the reality of crime risk reduction in Tokyo. These CVM formats were identically set for each respondent except for bid levels.

According to Hanemann et al. (1991), DB CVM works more efficiently than single bound to elicit preferences, which we employed in our survey. We first organized the burglary scenario to be evaluated and presented the DB CVM questions afterward. Then, according to the response to the first bid question, we presented the second one. We then presented the homicide scenario DB CVM (see also Appendix). In addition, each CVM question was organized with follow-up questions about the respondents' answers in order to eliminate protest responses.

We selected the bid levels of CVM with reference to the market price, which widely ranges from 100 to 15,000 yen, as detailed in Table 3. According to the Nihon Rock Co., Ltd. website, the price of security locks ranges from 2,980 yen to 24,800 yen[4]. According to the Kakaku.com Inc. website, the price of a portable alarm ranges from 115 yen to 7,980 yen[5]. To simplify designing scenarios and in order to cover the wide range of market prices for both goods, we decided to arrange the bid levels uniformly between the evaluated goods.

4 http://www.nihonlock.jp/ [Japanese only] (retrieved on 2nd Aug. 2011)
5 http://kakaku.com/ [Japanese only] (retrieved on 2nd Aug. 2011)

Table 3: Bid Level of CVM

		level 1	level 2	level 3	level 4	level 5	level 6	level 7
first bid		300yen	500yen	1,000yen	2,000yen	3,000yen	5,000yen	8,000yen
second bid	yeah response to first bid	500yen	1,000yen	2,000yen	3,000yen	5,000yen	8,000yen	15,000yen
	nay response to first bid	100yen	300yen	500yen	1,000yen	2,000yen	3,000yen	5,000yen

Subsequently, we asked the respondents who lived in a rental flat to provide the physical attributes of their current apartment, i.e., walking distance from the station, whether there is a park in the neighborhood, whether there is a convenience store in the neighborhood, and whether there is community safety in the neighborhood, in order to confirm their status quo and to promote relevancy in the CE questions.

The choice sets of CE were organized in the form of the next renewal/extension of the respondents' leases. Renting apartments is a frequent occurrence, which enables the respondents to easily imagine this situation. House owners were asked not to reply to the CE questions in our survey because it appears that purchasing a flat/house is not as frequent, which may lead to hypothetical biases.

We detail the attributes, their levels and expected signs in Table 4. First, distance from station on foot was defined as the required time to arrive at the nearest public transport station on foot. We expected that the respondents would prefer a location closer to the station. Second, we used neighborhood parks as a major concern when choosing a residential location in Japan. In the studies that employed a hedonic price approach, Troy and Grove (2008) investigated park accessibility as perceived as a proxy of neighborhood liability where lawless activities are prevalent in the US. On the other hand, Fierro et al. (2009) utilized neighborhood parks or green areas as a proxy disproportionate to crime rates in Mexico. Thus, we kept the expected sign undetermined. Third, convenience stores were defined as a major concern for Japanese residents. Recently, single households/ nuclear families have been increasing in Japan so there is a latent demand for convenience stores close to their homes in order to purchase daily necessities. Thus, we expected that a convenience store is a preferred amenity. Fourth, the change in general crime rates was employed to allow respondents to compare with the status quo or opt-out option, expecting a negative parameter estimate. Finally, change in rental costs was employed in order to compare with the status quo, as with the crime rate, anticipating a negative parameter estimate. Every attribute level was designed in order to mimic the real situations of rental flats in Tokyo.

In designing choice sets, we employed the main effects of the fractional factorial design in order to eliminate multicollinearity and to reduce from full profiles: $384 = 6*4^2*2^2$. Forty eight profiles were then incorporated into Plan 1 in the choice sets, subsequently randomized to be attached in Plan 2. We then blocked the choice sets into six groups to

create six versions of the questionnaire with the status quo attached. We provided CE question eight times to each group (see also Appendix).

Finally, we collected socio-economic information, such as age or income, and then finished the questionnaire.

Table 4: Attribute, Variable Name and Expected Sign of CE

Attribute (Variable Name)	Description and Level	Expected Sign
Distance from Station on Foot (Dsf)	The number of minutes it takes to walk to the nearest public transportation (for example, train or bus) station on foot Levels: 1 minute, 5 minutes, 10 minutes or 20 minutes (treated as a continuous variable).	Negative
Park in Neighborhood (Park)	Whether there are parks in the range of less than 5 minutes on foot. Levels: When there are, use 1; 0 otherwise.	Undetermined
Convenience Store in Neighborhood (Cs)	Whether there are convenience stores or shops such as supermarkets in the range of less than 5 minutes on foot. Levels: When there are, use 1; 0 otherwise.	Positive
Change in Residential General Crime Rate (Crime)	Change in the number of reported crimes per 0.1 million of the population compared to the current status of residential location. Levels: − 0.1%, − 0.05%, +0.05%, or +0.1% (which denote − 100 cases, − 50 cases, +50 cases or +100 cases per 0.1 million)	Negative
Change in House Rent (Rent)	Change in the cost of house rent per month compared to the current status of respondents. Levels: − 20,000yen, − 10,000yen, − 5,000yen, +5,000yen, +10,000yen or +20,000yen.	Negative

4. Econometric Methods

By using a principal component analysis (PCA), it is possible to identify psychological factors with multicollinearity eliminated. In the valuation studies, for example, Barton (2002) incorporated an attitudinal variable into the CVM analysis. Kontoleon and Yabe (2006) employed an exploratory factor analysis to identify a relatively few factors from 40 attitudinal variables and incorporated the factor scores into the LCM. Thus, we conducted PCA and incorporated the principal component scores as independent variables into the utility difference function of CVM and the membership function of LCM with CE, along with other covariates.

We then provided a random utility theory in order to derive econometric models of CVM/CE below. We define the indirect utility of the respondent who chooses alternative i as

$$U_i = V_i + \varepsilon_i \qquad (1)$$

where V_i denotes the deterministic component of the indirect utility, while ε_i describes the stochastic one. Actually, every discrete choice model begins with employing the additively

separable in the deterministic and the stochastic components, which we also follow (Louviere et al. (2000); Haab and McConnell (2002)). When it comes to the dichotomous CVM, i=1 denotes the alternative associated with the proposed scenario and i=0 the status quo. On the other hand, in CE studies, i is chosen among K alternatives.

4.1. Model for CVM

On CVM, the indirect utility of the respondent n (1… N) becomes

$$U_i\,(y_n, z_n, \varepsilon_{in}) = V_i(y_n, z_n) + \varepsilon_{in} \qquad (2)$$

where y_n denotes the respondent's discretionary income n and z_n the other characteristics or covariates (see also Haab and McConnell (2002)). First, the deterministic utility of the proposed scenario in CVM is expressed as

$$V_1(y_n - bid_n) = \alpha_1 z_n + \beta_1(y_n - bid_n) \qquad (3)$$

where α_1 denotes the parameter vector associated with the covariates, including a constant term, β_1 the marginal utility of income, and bid_n the bid level of the proposed scenario[6]. Second, the deterministic utility of the status quo in CVM is expressed as

$$V_1(y_n) = \alpha_0 z_n + \beta_0 y_n \qquad (4)$$

where α_0 denotes the parameter vector associated with the covariates, while β_0 is the marginal utility of income again. Third, the change in deterministic utility is

$$V_1 - V_0 = (\alpha_1 - \alpha_0) z_n + \beta_1(y_n - bid_n) - \beta_0 y_n \qquad (5)$$

Assuming that the marginal utility of income is constant - $\beta_1 = \beta_0 = \beta_{bid}$, - the utility difference function becomes

$$V_1 - V_0 = \alpha z_n - \beta_{bid}\, bid_n \qquad (6)$$

where $\alpha = \alpha_1 - \alpha_0$.

With the specified deterministic utility difference above, the logistic probability of yes to the

6 The parameter estimates in the discrete choice models are confounded with the scale parameter that is disproportionate to the variance of the stochastic component (Louviere et al. (2000)). We omit the scale parameter for simplicity and because it cancels out when estimating WTPs.

proposed scenario becomes

$$P(yes_n)=P(\alpha z_n - \beta_{bid}\, bid_n > \varepsilon_n)=[1+\exp(-(\alpha z_n - \beta_{bid}\, bid_n))]^{-1} \qquad (7)$$

where $\varepsilon_n=\varepsilon_{1n} - \varepsilon_{0n}$.
The mean WTP then becomes as follows (Haab and McConnell (2002) P.34):

$$mean\_WTP=\alpha/\beta_{bid} \qquad (8)$$

4.2. Models for CE

On the CE, one frequently defines the deterministic component of the indirect utility associated with alternative i in additively separable form (see also Louviere et al. (2000)):

$$V_i=\beta_i\, x_i \quad (9)$$

where xi denotes the attribute vector of alternative i with the associated parameter vector of marginal utilities, β_i.
McFadden (1974) showed that the choice probability of i among K alternatives becomes a conditional logit model (CL) with [a] type I extreme value distribution assumed on the stochastic component of the indirect utility:

$$P_i=\exp(V_i)/\sum_k \exp(V_k) \qquad (10)$$

According to Train (2009), Boyd and Mellman (1980) and Cardell and Dumber (1980) first applied the RPL or a mixed logit model to estimate choice probability with preference heterogeneities that could relax the assumptions of CL (Train (2009): p.134); that is, preference homogeneities and independence of irrelevant alternatives (IIA). For any alternative i and k, “the relative odds of choosing i over k are the same no matter what other alternatives are available or what the attributes of the other alternatives are" (Train (2009): 45-46.), amounting to very strict conditions. The choice probability of the response of the individual n who chooses alternative i among K is given as follows with the parameter space Ω:

$$\pi_{ni}=\int P_{ni} f(\beta|\Omega)\, d\beta \qquad (11)$$

where P is in the form of CL explicitly inducing the marginal utility of each respondent n. Revelt and Train (1998) demonstrated that RPL with repeated data. The choice probability

becomes

$$\pi_{ni}=\int\prod_{t \text{ in } T} P_{nit} f(\beta|\Omega)\, d\beta \qquad (12)$$

where t (t=1…T) denotes the number of times the respondent n answers. The degree of preference heterogeneities can be analyzed by calculating the coefficient of variation, Λ:

$$\Lambda = \sigma/\mu \qquad (13)$$

where σ denotes the standard deviation parameters of coefficients in Ω, while μ denotes the mean parameters.

Greene and Hensher (2003) compared LCM with RPL. Assuming that c (c=1…C) denotes the number of probabilistic segments to which respondents belong, the choice probability of the response of the individual n who chooses i among J then becomes

$$\pi_{ni}=\sum_c H_c P_{ni|c} \qquad (14)$$

where H_c consists of M (z_n), referred to as a membership function, showing why the respondent can belong to the unobservable segments c (c=1…C) with covariates, z_n. The membership function is frequently expressed in the form of a multinomial logit model, as in Greene (2003):

$$H_c=\exp(M_c(z_n))/\sum_c \exp(M_c(z_n)) \qquad (15)$$

LCM can improve analyses by taking repeated responses into account (Greene and Hensher (2003)):

$$\pi_{ni}=\sum H_c \prod_{t \text{ in } T} P_{nit|c} \qquad (16)$$

On LCM, the class number must be determined exogenously. There are several measures of model fitness to determine that number. Birol et al. (2009) employed the log likelihood (LL), McFadden's ρ (1 − LL/LL(0)), Bozdogan Akaike Information Criterion (AIC3: −2LL+3DF where DF is the degree of freedom), and Bayesian Information Criterion (BIC: −LL+(DF/2)*ln(N)). Thus, we employed these measures to identify the class number in the analysis below.

So far, it is quite difficult to determine which model is better with either criterion, RPL or LCM. Thus, we employ RPL in order to compare to CL and to grasp the overall

structure of the preference heterogeneity, while LCM is used to clarify the determinants of the heterogeneous preferences in detail with various covariates.

The marginal WTP (MWTP) of x in CE is estimated as follows, where βx denotes the parameter associated with the attribute x:

$$MWTP = -\beta_x / \beta_{bid} \qquad (17)$$

4.3. Estimation Procedure

We employed Limdep 9.0 with NLOGIT 4.0 in the estimation. Our estimation procedure is summarized as follows:

First, we adopted principal components with an eigenvalue greater than unity and interpreted the data by concentrating on component loadings greater than 0.5.

Second, on DB CVM, we utilized the procedure of Hanemann et al. (1991) and emphasized the significance of any parameters and AIC3. When incorporating covariates into the estimation, we employed stepwise regression with a forward selection procedure.

Third, on CE, we employed three models: CL as the basic model, incorporating every attribute of the choice set into the estimation; RPL as the model to grasp the overall feature of preference heterogeneity with a main emphasis on the significance of the standard deviation parameters and AIC3, utilizing the stepwise regression with the forward selection in incorporating each standard deviation; and LCM as the model to clarify the determinants of the heterogeneous preferences in detail, emphasizing mainly the significance of the parameters in the membership function and AIC3. When incorporating the covariates, again we employed the stepwise regression with the forward selection.

Finally, we adopted the Krinsky and Robb (1986) procedure with 1,000 times simulation to estimate the 95% confidence interval of mean WTP of CVM and MWTP of CE.

5. Results

As a result of PCA, we identified five principal components as shown in Table 5. We interpreted these components as follows: 1) PC1 denotes *less perceived damage from crime*; 2) PC2 denotes *less perceived cause and possibility of crime*; 3) PC3 denotes *agreement that the police function effectively, especially for homicide*; 4) PC4 denotes *trust in police efficacy as a whole*; and 5) PC5 denotes *agreement with self-responsibility of victims*. Then, we decided to use the principal component scores of these variables as the covariates of CVM and the independent variables in the membership function of LCM of CE.

Table 5: Principal Component Analysis

		Mean	S. D.	PC1	PC2	PC3	PC4	PC5	Contribution
There is a risk of victimization, which is up to me.	Burglary	4.119	2.549	−0.236	−0.592	0.040	−0.084	0.678	0.875
	Homicide	3.267	2.493	−0.243	−0.679	0.187	−0.097	0.515	0.829
Police can successfully reduce the number of victims.	Burglary	6.289	2.656	−0.470	0.102	0.464	0.662	0.029	0.886
	Homicide	6.148	2.762	−0.418	0.083	0.549	0.631	0.086	0.888
This kind of crime causes pain if I am victimized.	Burglary	8.304	2.649	−0.854	0.155	−0.143	0.005	−0.036	0.776
	Homicide	8.919	2.609	−0.829	0.140	−0.208	−0.043	0.063	0.757
It is dreadful if I am victimized.	Burglary	8.430	2.533	−0.838	0.155	−0.217	−0.022	−0.065	0.778
	Homicide	9.126	2.431	−0.788	0.122	−0.296	−0.152	0.150	0.768
There is high possibility that this kind of crime causes death.	Burglary	7.148	2.903	−0.606	−0.080	0.004	0.079	−0.286	0.462
	Homicide	8.859	2.566	−0.751	0.126	−0.240	−0.190	0.026	0.674
I am familiar with the cause of this crime.	Burglary	4.422	2.599	−0.339	−0.568	0.380	−0.293	−0.435	0.857
	Homicide	3.837	2.535	−0.358	−0.542	0.475	−0.291	−0.411	0.900
I am more likely to be victimized than others.	Burglary	3.333	1.781	0.072	−0.622	−0.562	0.388	−0.242	0.917
	Homicide	3.119	1.773	0.077	−0.569	−0.586	0.458	−0.146	0.904
Eigenvalue				4.437	2.260	1.838	1.451	1.285	
Proportion				31.692	16.144	13.128	10.361	9.177	
Cumulative Proportion				31.692	47.837	60.964	71.325	80.502	

Note: Likert Scale Format ranges from 1 (Strongly Disagree) to 10 (Strongly Agree). We concentrated on interpreting data in a mesh cell.

We present the results of CVM in Table 6. In both the burglary and homicide scenario, there were positively significant constant terms, which denote the value of the countermeasure, while there were negatively significant price terms (Bid), which is compatible with sound intuitions. We then incorporated the various covariates of demographics and psychological attitudes into the estimation. As a result, the number of family members was incorporated into the burglary model, while the household income per capita, which was calculated by dividing the household income by the number of family members, was incorporated into the homicide model. In the burglary model, WTP increases as the number of family members decreases. On the other hand, in the homicide model, WTP increases as the household income per capita rises. No other demographics or psychological attitudes were significantly estimated in either burglary or homicide. WTP for a 1/10,000 reduction of burglary risk was 15,580 yen in 2004 per household at mean and WTP for a 1/1,000,000 reduction of homicide risk was 12,877 yen.

Table 6: CVM Results

Burglary				
Variable	Coeff.	T value	Coeff.	T value
Constant	3.063***	15.453	4.030***	10.281
Bid	−2.249E −04***	−10.623	−2.314E −04***	−10.582
No. of Family Members			−0.149**	−3.126
No. of Obs.	431		431	
Log Likelihood	−287.144		−282.418	
McFadden's ρ	0.098		0.113	
	Estimate	95% CI	Estimate	95% CI
Mean WTP (Yen in 2004)	13,619.200	[15,514.513; 11,723.887]	15,579.506	[18,095.086; 13,063.927]
Homicide				
Variable	Coeff.	T value	Coeff.	T value
Constant	3.154***	13.783	2.648***	6.924
Bid	−2.300E −04***	−9.732	−2.308E −04***	−9.283
Household Income per capita			0.113*	1.797
No. of Obs.	337		318	
Log Likelihood	−229.386		−203.321	
McFadden's ρ	0.087		0.155	
	Estimate	95% CI	Estimate	95% CI
Mean WTP (Yen in 2004)	13,721.507	[15,819.476; 11,623.540]	12,877.191	[15,326.284; 10,428.099]

Note: The 1%, 5% and 10% significance levels are denoted by ***, ** and *, respectively. E-0X denotes 10^-X. The unit of WTP is yen per crime risk reduction at 1/10^4 for burglary and at 1/10^6 for homicide.

The results of CE with CL and RPL are provided in Table 7. These results suggest that preference heterogeneities exist because of the estimate of McFadden's ρ and the significance of standard deviation parameters in RPL, which encourages us to interpret in detail with LCM. The alternative specific constant (ASC) in the utility function of the status quo is significantly estimated, with which we aim to capture some willingness or reluctance to the current status. This indicates that people tend to prefer the current residential environment at mean because they are accustomed to it and/or are even satisfied with it, but there seems to be a heterogeneous preference for the status quo. Most of the remaining parameters were also significantly estimated. The coefficient of the distance from station on foot (Dsf) was significantly negative at mean in each model, while certain heterogeneities were indicated by the standard deviation estimates in RPL. The parameter for park in the neighborhood (Park) was positively significant with the significant standard deviation. This suggests that park accessibility is the proxy of an amenity at mean, while there is a certain heterogeneous preference. This is also proved by the largest coefficient of variation on Park. Thus, it is possible that the park accessibility denotes the proxy of either lawless activities or amenities thus far in the result of RPL. Convenience store in neighborhood (Cs) was

significantly positive in each model, which suggests that a convenience store is a preferred amenity. A negative coefficient was estimated for both changes in residential general crime rate (Crime) and in house rent (Rent), which coincides with our expectations. Then, MWTP for one case reduction per 0.1 million populations at mean was estimated at 181 yen in 2004.

Table7: Choice Experiment: Conditional and Random Parameter Logit Model

	CL				RPL			
Variable (Mean)	Coeff.	T value	MWTP	95%CI	Coeff.	T value	MWTP	95%CI
Dsf	−0.059***	−7.493	−1,317.971	−869.825; −1,766.117	−0.175***	−7.046	−1,673.580	−1,194.761; −2,152.398
Park	0.036	0.704	n.a.	n.a.; n.a.	0.399*	1.806	3,828.926	7,874.607; −216.755
Cs	0.171***	3.277	3,824.023	6,166.858; 1,481.188	0.731***	3.475	7,012.398	11,025.888; 2,998.908
Crime	−5.952E −03***	−7.690	−133.028	−89.413; −176.642	−0.019***	−7.416	−181.452	−135.842; −227.061
Rent	−4.474E −05***	−9.040			−1.043E −04***	−9.208		
ASC	0.858***	9.622			1.289***	3.852		
Variable (Standard Deviation)	Coeff.	T value			Coeff.	T value	Coeff. of Variation	
Dsf	n.a.	n.a.			0.135***	4.769	−0.771	
Park	n.a.	n.a.			1.318***	4.278	3.303	
Cs	n.a.	n.a.			0.899***	3.200	1.230	
Crime	n.a.	n.a.			0.014***	5.476	−0.737	
ASC	n.a.	n.a.			4.982***	7.167		
No. of Observation	949				949			
No. of Samples	120				120			
Log Likelihood	−832.12				−575.892			
McFadden's ρ No Coefficient	n.a.				0.444			
Constants only	0.111				0.383			

Note: The 1%, 5% and 10% significance levels are denoted by ***, ** and *, respectively. E-0X denotes 10^-X.

We demonstrate the fitness measures from the results of CE with LCM in Table 8, testing various combinations of covariates. All of the measures of fit indicate that three classes are likely to be supported. Thus, we report on only the results of the three classes in Table 9.

Table 8: LCM Fit Measure

	Log Likelihood	McFadden's rho	AIC3	BIC
2 classes	− 603.185	0.397	1,248.369	623.921
3 classes	− 532.789	0.454	1,137.578	568.246

Note: Values in bold denote the supported model. The 4 and 5 class models could not be estimated.

In the membership function of the LCM result, income and PC4 were incorporated, where the former was positively significant in both Class 1 and 2, and the latter was positively significant in only Class 2. Thus, those who are in a rather high income group are likely to belong to Class 1, while those who are in a rather high income group and are confident in the function of police as a whole are in Class 2. Those who are in Class 3 are from a rather low income group and distrust the function of police as a whole.

Table 9: Choice Experiment: Latent Class Model

	Class 1				Class 2				Class 3			
Utility Function												
Variable	Coeff.	T value	MWTP	95%CI	Coeff.	T value	MWTP	95%CI	Coeff.	T value	MWTP	95%CI
Dsf	−0.191***	−5.317	−1,592.375	−981.773; −2,202.978	−0.036***	−3.085	−484.457	−108.153; −860.761	−0.110***	−8.004	−3,178.251	−1,737.992; −4,618.510
Park	0.094	0.651	n.a.	n.a.; n.a.	0.257***	2.814	3,446.131	5,912.800; 979.462	−0.043	−0.545	n.a.	n.a.; n.a.
Cs	0.282*	1.712	2,356.177	5,172.414; −460.059	0.122	1.483	n.a.	n.a.; n.a.	0.276***	3.788	7,938.228	13,493.126; 2,383.330
Crime	−0.023***	−7.294	−190.575	−133.530; −247.620	−0.009***	−5.464	−116.783	−68.304; −165.182	−0.008***	−6.034	−216.587	−128.385; −304.789
Rent	−1.197 E −04***	−6.811			−7.472 E −05***	−7.055			−3.473 E −05***	−4.943		
ASC	0.869***	3.160			2.857***	16.981			−4.662***	−8.415		

Table 9 (cont'd)

		Class 1		Class 2		Class 3	
Membership Function		Coeff.	T-value	Coeff.	T-value	Coeff.	T-value
Constant		− 0.545	− 0.919	− 0.064	− 0.123	0	Fixed
Income		0.188*	1.848	0.164*	1.732	0	Fixed
PC4		0.034	0.124	0.468*	1.816	0	Fixed
Average Class Probability		0.326		0.462		0.212	
No. of Samples		114					
No. of Observation		901					
Log Likelihood		− 532.789					
McFadden's ρ	No Coefficient	0.454					
	Constants only	0.389					

Note: The 1%, 5% and 10% significance levels are denoted by ***, ** and *, respectively. E-0X denotes 10^-X.

For the utility functions, ASC was positively significant for the utility functions of Class 1 and 2, suggesting that some willingness to maintain the current status exists for both classes, while this is negatively significant in Class 3, suggesting a reluctance to remain at the current status. Every parameter of Rent in each class is negatively significant, while the other parameters are case by case for each class. Thus, we will discuss these with MWTPs in detail.

There are many differences of MWTPs among the classes: Members of Class 1, who are in relatively high income group and are willing to retain their current status, prefer more accessibility to the station, a convenience store in the neighborhood, and less crime risk;

Members of Class 2, who are also in a relatively high income group, trust the function of police as a whole, and are also willing to retain their current status, prefer more accessibility to station, a neighborhood park, and less crime risk; Those of Class 3, who are in a relatively low income group, distrust the function of the police as a whole, and are reluctant to retain their current status, prefer more accessibility to the station, the existence of a convenience store, and less crime risk. When comparing MWTP for crime risk, Class 2 members are the least willing to pay privately for residential crime risk reduction, those of Class 1 are moderately willing, and those of Class 3 are the most willing.

6. Discussion and Concluding Remarks

In review, our research interests have been organized as follows: 1) How much do the Japanese prefer averting behavior of particular crime risks if it is elicited by the utilization of familiar private goods; 2) How does crime risk affect residential choice; and 3) What and how do intangible/tangible covariates influence the public preference for crime risk reduction?

For the results of the CVM, we estimated the WTPs for certain countermeasures for reducing burglary risk at 1/10,000 to be 15,696 yen in 2004. On the other hand, 12,877 yen in 2004 was the estimate for WTPs for reducing homicide risk at 1/1,000,000. All of the WTPs appear to be reasonable private purchases in Japan. As for the estimated parameter of covariates, we interpret the results as follows: Single families are more willing to spend their disposable income in order to avert burglary risks because there are no other family members to help ensure home security and those of higher incomes are more willing to spend their disposable income in order to avert the homicide risk because they can afford to do so. This therefore suggests that family structure is related to property-crime-risk averting behavior and that income level is related to the risk of crimes against the person, while other demographics and psychological attitudes are not so related.

To the extent of our knowledge, there are few studies directly comparable to our CVM estimates except for Cohen et al. (2004). According to Cohen et al. (2004), the WTP estimate for a 10% reduction in burglary was $104 (95% CI: $93~$116) per household annually in the United States and the implied WTP for one case reduction was $25,000 ($21,000~$30,000). When we employ the real and effective exchange rate for 2004, the WTP for one case reduction in 2004 becomes approximately 2.6 million yen (2.1 million yen~3.2 million yen)[7]. On the other hand, our WTP estimate for one case reduction of burglary can be converted to approximately 156 million yen (130 million yen ~180 million

7 According to the Bank of Japan (http://www.boj.or.jp/en/index.htm/), the real and effective exchange rate in 2004 is 105.77 on annual average.

yen). In Cohen et al. (2004), the evaluated good is defined as the crime prevention program conducted by the associated community - a sort of public good - and the payment vehicle is the payment by the community. On the other hand, our evaluated good is the purchase of security locks to avert the private risk of being victimized - a sort of private good - and the payment vehicle is the private purchase. Though there may be some differences between countries regarding culture or ethnicity, the evaluated goods, either public or private, appear to be attributable to the difference of the WTP estimate between Cohen et al. (2004) and our study. This suggests that there is more WTP for particular crime risk reduction when explicitly defining personal crime risk reduction by using private purchases of countermeasures.

Second, as a result of CE with RPL, the MWTP estimate at mean is around 181 yen per general crime risk reduction at 1 case/100,000 population.[8] Park accessibility seems to be the proxy for amenities on average, but it is possible for it to function as the proxy for both lawless activities and amenities so far in the result of RPL. We then investigated the determination of heterogeneous preferences in detail by using LCM.

Third, as a result of CE with LCM, there are three types of members of the public. These types are distinguished by income level and trust in the function of police as a whole. Members of Class 3 are the most willing to pay privately for residential crime risk reduction, those in Class 1 are moderately willing to pay, and those in Class 2 are the least. Because members of Class 3 are the least trustful of the function of police as a whole, they are the most willing to pay privately for crime risk reduction; nevertheless, they are unlikely to be able to afford such an expense. On the other hand, because those of Class 2 have the most trust in the police, they are the least willing to pay privately; nevertheless, they are *likely* to be able to afford this expense. This suggests that people tend to view crime risk management as an individual responsibility when trust in the police is unlikely. In addition, the LCM result suggests that there are non-negative preferences for park accessibility, which indicates that the Japanese may view park accessibility as a proxy of amenity or do not consider it a major concern when selecting resident locations.

We tackled several topics: Willingness to pay for the personal reduction of burglary and homicide risk; public preferences for general crime risk reduction; and the influence of intangible/tangible covariates on preferences for crime risk reduction. Our CVM results suggest that certain demographics relate to crime type, while psychological attitudes may not. Thus, a prerequisite for economic studies of crime risk is to identify and select better covariates for estimating the benefits of particular types of crime risk reduction, while incorporating psychological attitudes towards crime risk may not be important. We have

8 Unfortunately, there are no studies comparable to our MWTP estimate to the extent of our knowledge.

also shown with the CE result how the intangible/tangible covariates affect the preference for general crime risk reductions when considering preference heterogeneities; this primarily indicates that confidence in the function of the police is influential on private WTP for general crime risk reduction. Of course, a major policy concern is to obtain, recover, and/or improve police credibility; another policy for the police department may be to promote collaboration with the private sector, including non-profit organizations and security firms, if it is difficult to achieve more trust. From all of the results, we can conclude that the benefits of crime risk reduction are quite large in Japan.

We finally conclude that the above results provide an avenue for future economic research on crime risk and/or community safety. Several topics remain. Our sampling may be ineffective, as mentioned above, so a more rigorous survey should be undertaken that reflects the characteristics of the general Japanese population. According to Braakmann (2009), property crime rates are related to the hedonic price in Germany. Thus, a residential CE should be conducted with crime risk specifically defined as property crime, not general crime. Furthermore, possible countermeasures, such as a portable alarm, may be investigated in order to employ a revealed preference method and to confirm the convergent validity with our results.

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Appendix

A: CVM Scenario

A1: Burglary Scenario

"Recently, there are many kinds of security goods being sold. We ask you to imagine that this is a door security lock capable of reducing the risk of your household being burglarized. When you and your family use this lock, the risk of burglary will be reduced by 1/10,000 during the next year, which is comparable to the reduction of one colored grid from 10,000 in the attached visual aid (see Figure A).

Please also imagine that this lock costs (*presented bid*) yen. Your disposable income will be decreased by this purchase, but you can successfully reduce the risk of burglary. Would you buy this lock?"

A2: Homicide Scenario

"Now, please imagine that this is a portable alarm that will enable you to reduce the risk of being the victim of a homicide. When you use this alarm, your risk of death by homicide will be reduced by 1/1,000,000 during the next year, which is comparable to the reduction of one cell from one colored grid divided by 100 from 10,000 in the attached visual aid (see Figure A).

Please also suppose that this lock costs (*presented bid*) yen. Your disposable income will be decreased by this purchase, while you can successfully reduce your risk of being the victim of homicide. Would you buy this alarm?"

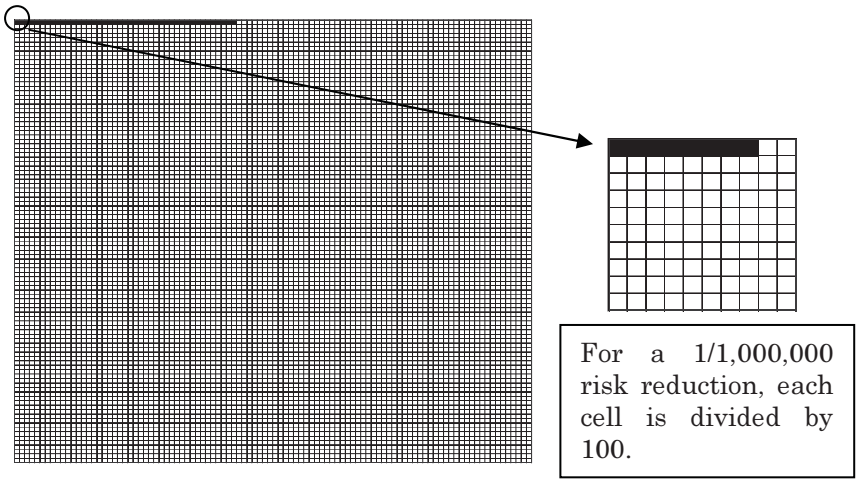

Figure A: Dot Image of Crime Rates (The scale of 43/10,000)

B: CE Scenario

"Now, please imagine that your next lease renewal for your rental flat is due and also suppose that there are two rental flats near your current flat that have almost the same size, arrangement, appearance and age except for their location and rental cost. Which flat would you prefer: Flat 1, Flat 2, or your current flat (Status Quo)? Please choose the most preferable one for each choice set below:

Note: Whichever flat you choose, your living circumstance will not change because Flats 1 and 2 are near the status quo. In addition, there are no other differences except for the attributes in each choice set. The questions will be repeated 8 times. Please choose the most preferable answer for each question with reference to the description of the attributes (Table B)."

Table B: Description of Attribute

Attribute	Description
Distance from Station on Foot	The number of minutes it takes to walk to the nearest public transportation (for example, train or bus).
Park in Neighborhood	Whether there are parks in the range of less than 5 minutes on foot.
Convenience Store in Neighborhood	Whether there are convenience stores or shops such as supermarkets in the range of less than 5 minutes on foot.
Change in Residential General Crime Rate	Change in the number of reported crimes per 0.1 million of the population compared to the current status of residential location.
Change in House Rent	Change in rent per month compared to the current status of respondents.

B1: Choose the Most Preferable Answer:

	Flat 1	Flat 2	
Distance from Station on Foot	5 minutes	10 minutes	Status Quo
Park in Neighborhood	Yes	No	
Convenience Store in Neighborhood	No	Yes	
Change in Residential General Crime Rate	− 0.1%	+0.05%	
Change in House Rent	+10,000yen	− 5,000yen	
Circle the Most Desirable Answer			