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1. Introduction

Poor households in developing countries often suffer from ill health and injuries, which can become a considerable economic expense for them. To alleviate this impact and complement existing informal risk-coping mechanisms, various types of micro health insurance (hereafter MHI) programs have been introduced. However, generally, the take-up rates for these programs have been low and even declining in some countries, although the potential demand for MHI should be high due to an expected increase of the relatively poor population who are vulnerable to unexpected health shocks in developing countries (De Janvry and Sadoulet, 2016). To grow the number of customers who purchase MHI, we need to investigate not only the reasons behind the low take-up rate, but, given the existing MHI scheme, also examine what alternative insurance schemes could induce more customers to purchase MHI.

A growing body of literature has investigated the reasons behind the low take-up rate.[1] However, regarding alternative MHI, few studies have investigated whether any alternative insurance schemes could induce potential customers to buy insurance (Nostratnejad *et al.,* 2016; Khan, 2013; Mulupi *et al.,* 2013; Harms, 2011). Among those, some are qualitative studies which do not facilitate analytical investigation. Others include approaches where respondents choose new insurance schemes altogether rather than augmented ones. Such methods do not enable a detailed analysis of the tradeoffs respondents make between insurance attributes. To rigorously analyze tradeoffs, discrete choice experiments (DCEs) are widely used as helpful methods in the field of healthcare preference studies (De Bekker-Grob *et al.,* 2012; Clark *et al.,* 2014).

Limited studies have applied DCEs to analyze the choices among alternative micro health insurance schemes. Abiiro *et al.* (2016) and Obse *et al.* (2016) apply discrete choice models for rigorous quantitative analysis of alternative MHI schemes in Malawi and Ethiopia, respectively, accounting for the tradeoffs among the attributes of the insurance schemes. However, the heterogeneity of consumer preferences affects the purchase decision as suggested by Adebayo *et al.* (2015). As a result, in consumer preference research, handling the heterogeneity of preferences is crucial (Swallow *et al.,* 1994); therefore, the heterogeneity of consumer preferences for MHI should be taken into consideration as well. Regarding this point, Abiiro *et al.*'s (2016) study is the only one that investigates the heterogeneity among socio-demographic characteristics that determine the preference for one of two types of MHI by using DCE and mixed logit models.

Our study examines the impact of heterogeneous socio-demographic characteristics on the purchase decision by extending the mixed logit model with a series of interaction terms

[1] These reasons include health condition, experiences of health shocks, other household characteristics (e.g., income and assets, age, education, gender, and household size), and a distrust of insurance agencies and medical service providers (Ekman, 2004; Adebayo *et al.,* 2015). Risk aversion and hyperbolic time preferences may also affect the purchase decision (Ito and Kono, 2010).

between respondent characteristics and attribute levels. The objective of our study is to evaluate the demand for different attributes of micro insurance and identify which MHI is more acceptable in Cambodian where 40% of the population is relatively poor and not covered under any health insurance scheme (Cambodian Ministry of Health, 2016), while taking into account the preference for insurance caused by the heterogeneity of socio-demographic characteristics. To that end, we estimate the "willingness-to-pay" (WTP) for different attributes, employing the DCE and the latent class model (LCM), which has been utilized to approach heterogeneity problems in many fields including health economics (Atella *et al.,* 2004; Bago d'Uva, 2005; Sarma and Simpson, 2006; Raghavan *et al.,* 2008; Schokkaert *et al.,* 2010).

In Cambodia, MHI has been available to poor households since 1998. During the initial stage, it was only the voluntary type which had been funded and assisted by donors. Since 2000, the Cambodia Health Equity Fund (HEF) for the population living below the poverty line was launched, receiving financial support from donors. Under HEF, the poor can receive free medical services. After 2008, HEF has been funded by the government. Around this time, foreign donors withdrew from MHI projects and the operation of HEF for the poor and voluntary MHI for the relatively poor was transferred to local NGOs until 2017. This was because the Cambodian government stopped providing subsidies to nongovernmental organizations (NGOs) that have operated HEF and voluntary MHI programs because of the low take-up rate since 2017. Therefore, after 2018, NGOs have ceased the operation of MHI programs due to a lack of funding.

The standard MHI in Cambodia today consists of six attributes: benefit package coverage, the service providers, the management system, participation by the non-poor and discounting, the contract term, and timing. Notably, treatment of chronic diseases and dental care have been excluded generally from the benefit package, even though the demand for such treatments is strong (Bigdeli *et al.,* 2016). In addition, although the potential patients trust private medical providers (Ozawa and Walker, 2011), private clinics have not been included among the service providers. Further, existing MHI programs have had problems with the unfair treatment of the insured by doctors and nurses in public hospitals, and with explanations that should have assisted potential purchasers in fully understanding the insurance[2]. Therefore, if the six attributes are improved, MHI could potentially attract more insurance purchasers.

To pinpoint alternative MHI schemes that might induce customers to purchase insurance, we designed alternative attributes that include the treatment of chronic diseases and dental care, treatment in private clinics, and an improved management system. We then evaluated the WTP for these improved attributes of the MHI scheme by applying the DCE–LCM. The rest of this article is organized as follows. Section 2 describes our data collection method and the methodology of the DCE-LCM. Section 3 discusses our results. Finally,

[2] According to interviews with MHI NGOs, changes in the premium discount system, contract term, and the timing of the contract may have affected take-up rates (Yagura, 2014).

Section 4 presents a discussion of policy implications and the need to increase the MHI take-up rate in Cambodia.

2. Methodology

2.1 Data collection

We selected the Tram Kak District of Takeo Province in Cambodia as the study area. The main reasons for this are as follows. The voluntary MHI in the Ang Roka health operation district, including the Tram Kak administrative district, had the longest history in Cambodia. Additionally, the operation district had been the main target area of the MHI project which was funded and operated by the French NGO, Groupe de Recherche et d'Echanges Technologiques (GRET), from 1998 to 2011. It also had the highest insured population among six operation districts in the province when GRET had operated it. Therefore, we assumed this district had the largest population of people with good knowledge about voluntary MHI.

We conducted a field survey in September 2014 in this district in 12 villages from three communes. We selected the communes by using stratified random sampling where the MHI

Table 1. Characteristics of Sample Households

Household size (people)	4.51
Household labor (people)	2.68
Household head's age (years)	47.32
Household head's gender (1=male)	0.81
Household head's education (years)	6.18
Main occupation of household head (%)	
Agriculture	48.90
(Non-agri.) self-employed business	11.54
Driver, carpenter, repairperson	14.56
Permanent wage labor	12.91
Daily wage labor	10.99
Others	1.10
Remittance received (thousand riels[a])	1,974.13
Owned land area (m^2)	6,669.84
Total value of agricultural tool (thousand riels)	930.66
Total value of livestocks (thousand riels)	6,356.95
Total value of durable goods (thousand riels)	5,479.48
Debts (thousand riels, past 5 years)	
Formal loan	3,600.39
Informal loan	147.93
Saving / fertilizer group (1=member)	0.31
Experience of purchasing MHI ever (1=purchased)	0.51
Experience of purchasing MHI at present (1=purchased)	0.29

Source: Household survey data.

[a] Riel is the Cambodian currency, 4,000 riels = 1 USD.

was available; we then selected 12 villages where the take-up rate was relatively high. Next, considering the sample-to-population ratio used in the Cambodia Socio-Economic Survey (0.38% of households), statistical theory on appropriate sample size, and cost constraints, we determined the number of sample households in each village, set to be nearly proportional to the total number of village households across villages. Then, we randomly selected 443 sample households from the lists of village households from the village chiefs. We interviewed with one major decision maker (e.g., the household head, spouse of the household head, or an adult responsible for managing household income) in each household.

As the average health insurance take-up rate in the surveyed villages was only 15% (307 households among total 2049 households), which is potentially too small to undertake appropriate analyses, we intentionally raised the ratio of insurance buyers to 30% to obtain statistically valid results.[3] We divided all households in the villages into two groups: 134 insurance buyers (insured) and 309 insurance non-buyers (uninsured). Then, we randomly selected around 30% of our 443 households in the sample from the group of insured households and 70% from the uninsured household group. In our analysis, we used data from the 364 households with complete information and the characteristics of the sample households are shown in Table 1.

2.2 Experimental design

To evaluate the preferences for different insurance scenarios, we applied the DCE, using questionnaire surveys with hypothetical choice situations to analyze preferences for alternative insurance contracts. Here, we used a table with six alternative insurance contract scenarios and asked the respondents to choose the insurance contract they preferred. In DCE studies, the appropriate selection of the attributes and their levels that create these hypothetical scenarios is important. The alternative scenarios had different combinations of attributes. Based on the information derived from the literature (Bigdeli, 2016; Ozawa and Walker, 2011; Yagura, 2014), we selected the following six aforementioned attributes that would affect the village take-up rate, and timing and period of the insurance contract. Most of the attributes had four levels, except the per capita premium which had six levels. The definitions are detailed in Table 2.

In the questionnaire, we presented the respondents with a choice set (profile) with six scenarios and asked them to select the most preferable one. Using random number table selection and by omitting unrealistic scenarios, the six scenarios were chosen from 24 profiles including the current insurance profile. Thus, we created four profiles per respondent and randomly presented these to the respondents (Table 3). The respondents who did not have any preferable choice set had an opt-out option. When implementing DCE, interviewers guided respondents on how to answer questions, if any, to lessen the psychological burden to choose one out of six insurance scenarios. To examine preference heterogeneity, we conducted inter-

[3] In the robustness tests, we found no effect of increasing the ratio of insurance buyers in our sample.

Table 2. Alternative Micro-insurance Scheme

Attribute	Level	Definition
Premium:	1	1-person family: 1,000 riels/family/month
	2	1-person family: 2,000 riels/family/month
	3	1-person family: 3,000 riels/family/month (pre-existing system)
	4	1-person family: 4,000 riels/family/month
	5	1-person family: 5,000 riels/family/month
	6	1-person family: 7,000 riels/family/month
Providers:	1	RH (District Hospital) and PH (Provincial Hospital)
	2	HC (Health Center), RH, and PH (pre-existing system)
	3	HC, RH, PH, and Local Private Clinic
	4	HC, RH, PH, Local Private Clinic, and Private Hospital in Phnom Penh
Coverage of Medical Treatments:	1	Cover only outpatient services
	2	Cover inpatient services & outpatient services (pre-existing system)
	3	Current benefit package + basic dental care & eye doctor
	4	Current benefit package + long term treatment of chronic disease and basic dental care & eye doctor
Management:	1	Pre-existing system
	2	Current system + Doctors & Nurses join the meetings to explain MHI scheme
	3	Current system + Doctors & Nurses join the meetings to explain MHI scheme + Monitoring medical service providers by NGO staff
	4	Current system + Doctors & Nurses join the meetings to explain MHI scheme + Monitoring medical service providers by NGO staff + Collection of insurance fee by authorized person
Participation of Non-poor & Discount:	1	No regulation: pre-existing system
	2	If less than 30% of non-poor households in the village participate, any household cannot participate in MHI. However, if more than 30% of non-poor participate in MHI, the 80% discounted fee is applied for all the participants.
	3	If less than 40% of non-poor households in the village participate, any household cannot participate in MHI. However, if more than 40% participate in MHI, the regular fee is discounted by 70%.
	4	If the less than 50% of non-poor households in the village participate, any household cannot participate in MHI. However, if more than 50% participate in MHI, the regular fee is discounted by 50%.
Timing & Duration of Payment:	1	Minimum contract term: six months or one year. Participants can sign a contract anytime (pre-existing system).
	2	Minimum contract term is one year. Participants can sign a contract any time.
	3	Minimum contract term is one year. Participants can sign a contract only in January.
	4	Minimum contract term is more than one and a half years. Participant can sign a contract only in January.

views to capture the household and individual characteristics including risk and time preferences, following the methods of Schechter (2007) and Kirby *et al.* (2002).

Table 3. Example of Choice Set

Q. Which do you prefer as the best from the 7 choices? : _____
If no choice, which type of scheme is the one relatively preferred? : _____

Type of Micro Health Insurance Scheme							
Attribute	Choice Set 1	Choice Set 2	Choice Set 3	Choice Set 4	Choice Set 5	Choice Set 6	No choice
Premium (1,000-7,000)	1,000	2,000	2,000	4,000	4,000	5,000	
Provider (1-4)	2	2	3	4	5	5	
Benefit Package (1-4)	1	4	3	5	4	5	
Management (1-4)	1	1	3	3	5	5	
Participation of non-poor (1-4)	1	1	2	3	3	2	
Timing & duration of payment (1-4)	1	1	4	2	3	1	

Note: The numbers indicate the levels of the attributes shown in Table 2.

2.3 Analytical Model: Conjoint Analysis with Latent Class Model

We first constructed a conditional logit model based on the random utility theory. The probability that participant *i* chooses the *j*th alternative with attributes x_i is expressed as

$$f_i(j|\beta) = \frac{exp(x_i \boldsymbol{\beta_s})}{\sum_{k \in C} exp(x_i \boldsymbol{\beta_s})} \quad (1)$$

where x_i is the vector of participant *i*'s *j*th alternative with attributes: premium, provider, benefit package, management, participation discount, and timing. β_s is a preference parameter for the corresponding variable of x_i. Assuming that the class membership function π_{is} explains the probability that the participant is classified into Class *s*, the function can be expressed as

$$\boldsymbol{\pi_{is}} = \frac{\exp(\boldsymbol{z_i \lambda_s})}{1+\sum_{s=1}^{S-1} \exp(\boldsymbol{z_i \lambda_s})}. \quad (2)$$

where z_i is participant *i*'s individual demographics such as gender, age, education, assets, and risk preferences. We chose the combination of demographic variables such that the log-likelihood function was maximized. The log-likelihood function of the joint density of all individuals is expressed as the latent class model as follows:

$$\ln L = \sum_{i=1}^{I} \sum_{s=1}^{S} d_{is} \ln(f_i) + \sum_{i=1}^{I} \sum_{s=1}^{S} d_{is} \ln(\pi_{is}). \quad (3)$$

In the latent class model, the total number of classes (*S*) for estimation need to be pre-specified. We began with $S = 1$, which is equivalent to assuming homogeneous preference. We then repeated the estimation by increasing the size of classes and compared the results for model fit. Once the parameters, $\widehat{\boldsymbol{\beta}}_{\boldsymbol{s}}, \widehat{\boldsymbol{\pi}}_{\boldsymbol{s}}$, are estimated according to Bayes' rule, the individual's class membership probability, $\widehat{\boldsymbol{P}}_{\boldsymbol{is}}$, can be probabilities how likely individual *i* is to be categorized into Class *s* as follows.

$$\widehat{\boldsymbol{P}}_{\boldsymbol{is}} = \frac{\widehat{\pi}_{\mathbf{is}} f_i(\widehat{\beta}_s)}{\sum_{s=1}^{S-1} \widehat{\pi}_{\mathbf{is}} f_i(\widehat{\beta}_s)} \quad (4)$$

where $\sum_{s=1}^{S} \widehat{\boldsymbol{P}}_{\boldsymbol{is}} = 1$. By letting the LCM categorize respondents based on the class membership function, we are able to understand how the consumers' preferences diverge.

3. Results and Discussion

Our results confirm that a two-class model demonstrates the minimum consistent Akaike information (CAIC), and the difference in $\ln L$ is also larger than in other classes. Hence, we adopted the two-class model as the most efficient model in this study. We report only the results of the two-class model because it is the most efficient model. Since the calculation with the expectation-maximization (EM) algorithm used in this analysis is apt to converge in a local maximum, we iterated each latent class model 100 times with randomly selected initial values, adopting the highest CAIC among the results.

The results of the primary model (conditional logit model) are shown as a one-class model on the left side of Table 4. As shown, the coefficient of premium is significantly negative and the coefficients of provider, benefit package, and participation are significantly positive. This indicates that when the number of medical service providers increases, the coverage of medical service widens, and when the discount for village participation rises, the probability of insurance take-up improves. By contrast, if the premium increases, the probability declines.

The estimation results of the latent class model are shown as a two-class model on the right side of Table 4. The class membership function of LCM mainly bases respondents' education level and the experience of injury to categorize them into the groups. The table shows that the estimated coefficient of premium in the first class is insignificant. This means that 40% of the people do not rely on any of the six attributes when choosing MHI. Insignificance on the premium means that the people in the group do not have a WTP for the respective attributes. However, 60% found some significant relationship with not only premium, but with most of the attributes as well. Therefore, we focused on the estimation results of the second class.

The results of the second class show that the coefficients of premium, provider, benefit package, and participation are significant and have the same signs as in the primary model. However, the results differ in that the coefficient of management is significantly positive. This result implies that if the management system is strengthened, the take-up rate probability will increase. The results of the latent class model also show that the magnitudes of the impacts of the attributes on the probability are larger than those in the primary model.

According to the estimation result of class membership in Table 4, the average years of education for the household head in the second class was higher at 1% significance level. Further, their remittance receipts from migrant family members and assets were larger than for members in the first class, which may affect demand for health insurance. As for loans,

Table 4. Estimation Results (Conditional Logit and Latent Class Model)

	1 Class		2 Class			
VARIABLES	Cond. Logit		Class 1		Class 2	
Attributes						
Premium	-0.0002	***	0.000012		-0.00042	***
	(0.0000)		(0.000046)		(0.000051)	
Provider	0.23929	***	0.12	*	0.41	***
	(0.0304)		(0.063)		(0.056)	
Benefit package	0.563036	***	0.047		1.09	***
	(0.0324)		(0.079)		(0.096)	
Management	-0.02432	***	-0.051		0.2	***
	(0.0243)		(0.054)		(0.043)	
Participation of Non-poor	0.10733	***	0.054		0.12	**
	(0.0296)		(0.061)		(0.049)	
Timing & Duration of Payment	0.020803		0.0026		0.056	
	(0.0294)		(0.054)		(0.051)	
Class membership (Probability)						
Household Head's Age	-		0.019		0.00	
			(0.012)			
Household Head's Education	-		-0.16	***	0.00	
			(0.056)			
MHI at present	-		0.34		0.00	
(1 if household now purchases						
MHI, 0 otherwise)			(0.39)			
Medical evaluation	-		-0.24		0.00	
(1=very good - 5=very bad)			(0.29)			
Amount of Remittance from	-		-1.20E-07	*	0.00	
Migrant Family(Riels)			(6.4e-08)			
Experience of Illness	-		-0.67*		0.00	
			(0.41)			
Experience of Injury	-		0.89	**	0.00	
			(0.42)			
Number in household	-		0.42		0.00	
under 5 years			(0.27)			
Village dummy	-		0.1	*	0.00	
			(0.058)			
Constant	-		-0.30		0.00	
			(0.88)			
Class proportion	1.000		0.396		0.600	
Log-likelihood	-2,329.29		-2,220.04			
CAIC	-		4,591.643			
Observations	8,526		3,376		5,150	
Number of respondents	364		144		220	

Notes: *, **, and *** denote statistical significance at the levels of 1%, 5%, and 10%, respectively.
Values in parentheses denote standard errors.

members in the second class received more informal loans. They were also more likely to face illness and less likely to purchase insurance now. A notable difference was that members in the second class suffered more from external shocks than those in the first class. Finally, the difference for time preference for the present versus time preference for six months from now

Table 5. Attribute Evaluation (Logit and Latent Class (Two-Class) Models)

MWTP	First Class	Second Class	
	Conditional Logit Model	First Class	Second Class
Provider	1,180	-10,000	976
Benefit package	2,776	-3,917	2,595
Management	-120	4,250	476
Participation	529	-4,500	286
Timing	103	-217	133
Class proportion	100%	40%	60%

(an indicator of present time bias) was larger for the first class, though not statistically significant. This may suggest that present time bias has a positive effect on the members in the first class.

Next, we present the marginal WTP (MWTP) calculated from the estimation results of the parameters (Table 5). The left side of Table 5 shows the attribute evaluation results from the parameters in the primary model and the right side shows those in the latent class model. If we compare these values, we see that the attribute evaluations calculated from significant parameters in the primary model are larger than from those in the latent class model. This is partial evidence that the latent class successfully copes with the heterogeneity of consumer preferences, since we are able to separate the first class respondents, who are not interested in any of the attributes described, from the sample population. Here, we focus on the attribute MWTP calculated from the estimation results of the latent class model. Among the five attributes, the improvement in the benefit package was the one evaluated the highest. This implies that there is a strong demand among potential customers for wider medical service coverage that includes chronic diseases and basic dental care, consistent with the findings of Bigdeli *et al.* (2016).

The respondents gave the second highest evaluation to an increase in the providers of medical services. This suggests that potential clients have a strong demand for medical services from local private clinics and hospitals in Phnom Penh, consistent with the findings of Ozawa and Walker (2011). In terms of the insurance management system, the respondents positively evaluated the introduction of a monitoring system to mitigate distrust of service providers and a system that ensures a more careful and clearer explanation of the terms of the insurance. This suggests that potential customers have a WTP a higher premium if the insurance systems are more carefully and plainly explained and a monitoring system of medical institutions is introduced. These findings are supported by the fact that after the MHI in Siem Reap Province (Sahakum Teanea Raprong Sokpheap Angkor Chum) introduced a monitoring system, the

number of insurance purchasers increased remarkably (Yagura, 2014). The evaluations of the discount schemes were relatively low. One possible explanation is that due to possible difficulty in obtaining consensus among the richer residents in the village, the respondents were not confident of achieving higher participation in the village even if premiums were discounted when participation increased.

From the results for the latent class model, we can expect that the respondents in the second class would be willing to pay 4,466 riels if the existing micro health insurance scheme (premium 2, provider 2, benefit package 3, management 1, discount for participation rate 1, timing & contract period 1) was upgraded by one level. This suggests that if the existing micro health insurance scheme is improved, more than 60% of the respondents would be willing to purchase the insurance even if the premium increased more than 4,000 riels per person per month.

4. Conclusion and policy implications

This study applies a latent class model to evaluate the demand among potential customers with heterogeneous preferences for MHI attributes to identify more acceptable insurance schemes for rural Cambodia. The main findings are as follows. In the comparison of the two classes, the second class, comprising household heads who were younger and well-educated, with more remittances from migrant family members, more assets, and facing more illness, was significantly responsive to improvement in the insurance schemes. As for present time bias, we could not find any evidence that supports the hypothesis that it negatively affects WTP for MHI.

In addition, our findings suggest that potential insurance customers who would have purchased MHI accounted for more than 60% in our study area, even if the premium increased by 4,000 riels per person per month. This implies that if improving the MHI scheme does not cost more than 4,000 riels per person per month, a considerable number of customers would purchase it. Thus, our results can be used to support improvements in existing MHI to attract more MHI customers. This, then, will have a cascade effect of reducing health spending among the poor in Cambodia (Levine *et al.,* 2016).

Our findings contribute to the literature by adding to the limited evidence about individual preferences for attributes of MHI in developing countries. Our study also offers valuable information that can be used by healthcare authorities and development assistant agencies to provide health insurance to the relatively poor population who account for a large percentage of the total population and are not covered by health insurance in low- or middle-income countries like Cambodia. This study, however, does not examine the extent to which the cost might rise if the insurance scheme is improved. If those costs exceed the revenue from the improved insurance contract, the improved insurance would not be sustainable. This topic is reserved for future research.

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