Pre-print of the paper later printed as

Zheng, Y., J.B. Jacobsen, B.J. Thorsen and Z. Liu, 2019: How do rural households prefer to adapt livelihoods to economic effects of climate and policy changes? Forthcoming at *Singapore Economics Review*, https://doi.org/10.1142/S0217590819500061

How do rural households prefer to adapt livelihoods to economic effects of climate and policy changes?

1. Introduction

The need to better understand how societies may anticipate and adapt to future changes has been increasingly emphasised (Dearing et al. 2010). This plays an important role in how climate and other changes may impact societies (Patt 2007). Understanding how people expect to respond to changes provides timely guidance for policy design enhancing adaptation where needed, as well as lending insights into how policy options may foster different types of responses (Patt et al. 2010).

Some earlier studies (e.g., Evans et al. 2013; Valkering et al. 2011) elicited stakeholders' perceptions and opinions of possible scenario developments and their desired adaptation outcomes. Such data has been analysed using statistical approaches in attempts to characterise how specific groups of people choose certain adaptation responses to different scenarios (e.g., Cinner et al. 2011; Nainggolan et al. 2011). Freier et al. (2012) quantified adaptation behaviour and linked it to subjective expectations (e.g., prestige). However, their method failed to relate social-economic household features to adaptation choices. These studies provide useful insights into contextualised and locally perceived changes and future adaptations, yet they have not explicitly investigated how changing properties of the social-ecological systems can affect individual decision-making in quantitative terms. Choice experiment (CE) - a stated preference technique (Freeman, 2003) - is increasingly used as a tool to investigate likely behavioral responses to future policy making in a developing country context (e.g., Nguyen et al. 2013, Kassahun et al, 2016), and its validity as an approach for *ex ante* impact assessment is acknowledged (e.g., Rakotonarivo et al. 2017).

In this paper we demonstrate how CE can be a useful vehicle examining *ex ante* how households expect to adapt to future economic impacts of climatic and policy changes. Specifically, we use a Chinese case study of rural households subjected to ongoing changes to demonstrate how CE can be used to address the research questions:

- How do households expect to adjust their livelihood strategies to climatic and policy changes that affect the income potential of different strategies?
- What factors shape their responses and what does this imply for policy design?

The study contributes in three ways. First, the study demonstrates how CE is useful for investigating *ex ante* likely adaptation to change. This contributes to advancing quantitative assessments by enabling inquiries into 'how much more likely' particular adaptation strategies are, given certain attributes of contextual changes and agent characteristics. Second, we demonstrate how adaptation may take place in the form of adjustments made to current livelihood strategies (Kates et al. 2012). This contrasts with actions that start completely from scratch (e.g. Nielsen et al. 2014, Kassahun and Jacobsen, 2015). Third, the study contributes with locally specific insights based on empirical data collected from three villages along a climate gradient in Yunnan province. Despite the local specificity, the results are relevant for understanding adaptation behaviour in similar rural communities.

2. Study area and livelihood patterns

2.1 Livelihood patterns

We chose three distinct upland communities in Lijiang situated in north-western Yunnan province; namely Wenhai (2400m), Xihu (2800m) and Wuzubi (3200m) inhabited by Naxi and Yi people.

The three communities are endowed with diverse biophysical, socio-economic and institutional contexts, which have given rise to varied livelihood patterns. During the past decades, livelihoods have undergone significant changes due to a series of natural events and policy interventions (Zheng et al., 2012).

Broadly, we have identified four livelihood sectors in the study area, including agriculture (A), tourism (T), business (B) and migrant work (C)[1]. Each sector consists of a range of activities either currently practised by households or exhibiting potential to be developed. Although some households allocate almost all time, labour and money in one principal activity, most households undertake more than one income generating activity. Agriculture includes crop production, fruit tree plantation, livestock rearing and cultivation of medicinal plants. Tourism primarily includes activities like horseback riding and 'farm house stay'. These activities require some financial capital for entry (e.g., to raise horses, to decorate farm houses) and human capital for implementation (e.g., to pull horses

[1] We are aware that certain livelihoods have not been captured in the categorisation of livelihoods, including activities such as illegal logging/charcoal making and other income sources including remittance and payments gained from environmental protection programs (e.g., Sloping Land Conversion Program). The former group is left out because these activities are implemented as supplementary activities during agricultural/tourism downtimes or as short-term coping strategies in case of extreme weather events or other shocks. We do not include the latter group, as households cannot choose freely to participate in these activities.

for tourists, to manage farm houses). Business activities include transportation services, auto-mechanics, retailing of non-timber forest products (NTFPs), and running kiosks and game parlors (for the Chinese Mahjong game) in the village. These are mostly done by wealthier households who can afford to own and operate cars and shops. Business is usually maintained by household members and operated with a long-term perspective. The activities require capital, network and skill to provide high returns. Due to absence of credit schemes in the study area, the start-up capital for business is probably sourced from surpluses arising in other activities.

Migrant work refers to 'circular migration' where household members shift between work in the urban economy and family farming (Ellis 1998). In China's context, circular migration refers specifically to rural residents who are registered under "agriculture Hukou" (as different from urban residents who possess "non-agriculture Hukou") and shift between cities and family farming during the year. The usual case for rural households investigated in this study is to work temporarily in nearby towns/cities (e.g., Diqing, Shangri-La) mainly in construction and tertiary service sectors.

2.2 Current livelihood portfolios of sampled households

Major parts of the households in the study area rely on a two-component strategy (46.58%) cf. Table 1. In total, 161 households are included in the analysis. Households having a single-component strategy focus primarily on the agriculture sector (37.89%). Only 11.18% of households pursue a three-component strategy and a four-component strategy is even rarer. The option to have T income is part of all strategies beyond two components. There is remarkable heterogeneity across villages. Around half of Xihu and Wenhai households practise a two-component strategy, combining agriculture and non-agriculture options, while the largest portion of Wuzubi households earn their living solely from agriculture (61.11%).

Table 1 Current livelihood portfolios of sampled households

Livelihood	Xihu (n = 32)	Wuzubi (n = 54)	Wenhai (n = 75)	Total (n = 161)
Single-component strategy	9 (28.13)	33 (61.11)	22 (29.33)	64 (39.75)
A	9 (28.13)	33 (61.11)	19 (25.33)	61 (37.89)
B	0 (0.00)	0 (0.00)	2 (2.67)	2 (1.24)
C	0 (0.00)	0 (0.00)	1 (1.33)	1 (0.62)
Two-component strategy	17 (53.13)	20 (37.04)	38 (50.67)	75 (46.58)
A&B	2 (6.25)	12 (22.22)	3 (4.00)	17 (10.56)
A&C	3 (9.38)	8 (14.81)	19 (25.33)	30 (18.63)
A&T	12 (37.50)	0 (0.00)	16 (21.33)	28 (17.39)
Three-component strategy	5 (15.63)	1 (1.85)	12 (16.00)	18 (11.18)
A&B&C	0 (0.00)	1 (1.85)	0 (0.00)	1 (0.62)
A&B&T	2 (6.25)	0 (0.00)	1 (1.33)	3 (1.86)
A&C&T	3 (9.38)	0 (0.00)	11 (14.67)	14 (8.70)
Four-component strategy	1 (3.13)	0 (0.00)	3 (4.00)	4 (2.48)
A&B&C&T	1 (3.13)	0 (0.00)	3 (4.00)	4 (2.48)

Note: Percentages in parenthesis. One household not included as none of its income sources came from these four livelihood sectors.

3. Hypotheses

The convergent impacts of climate and socio-economic changes have shaped adaptation of many rural households in the developing world (e.g., Reenberg et al. 2008; Nielsen and Reenberg 2010). The simultaneous exposure to social-economic and environmental risks brings varying consequences to different sectors (O'Brien and Leichenko 2000), which are closely tied to different aspects of rural livelihoods. Building on this, we assume that households respond to the resulting income changes of different livelihood sectors, and that households prefer to adapt by increasing efforts in activities, which are projected to see positive income changes and reducing efforts in activities predicted to see income declines.

As mentioned, government policies have been significant drivers of livelihood changes in the study area, by regulating access to specific types of assets that affect households' adaptive capacities (Zheng et al. 2012). In this study, we consider government policies that subsidise agricultural inputs (such as seeds/seedlings, fertilizers, fodder), provide access to credit or improve welfare benefits to migrant workers (e.g., minimum wage, health and unemployment insurance, free legal assistance). These policy tools are likely candidates as they have received increasing attention (e.g., Li 2006; Gale et al. 2005). They are expected to reduce potential entry barriers for certain livelihoods in the study area. Specifically, we expect agricultural subsidies and credit support to promote the uptake of A, B and T, and to discourage the participation in C. On the other hand, policies improving protection of migrant workers will likely increase C.

Previous findings suggest the need to analyse a range of factors to assess households' ability to adapt. These include historical responses to different types of changes as well as households' assets, such as natural capital (e.g., farmland), human capital (e.g., education level, labour availability), physical capital (e.g., tractors, cars) and social capital (e.g., trust) (Scoones 1998; Reardon 1997; Berhanu et al. 2007). The present study considers a certain set of asset variables based on existing literature and makes hypotheses as detailed below.

A positive relationship has been found between farmland holding and the adoption of pure-farming strategies (e.g., Hatlebakk 2012), and non-farm activities in light of the start-up investments derived from the surplus of agriculture income (e.g., Abdulai and CroleRees 2001). For this study, we anticipate that households, who are richer in farmland (i.e., natural capital) are more likely to undertake A and B activities in the face of change. Findings suggest that education increases the adoption of non-farm activities (e.g., Eneyew 2012; Adi 2007; Cunguara et al. 2011), and non-farm labor allocation is associated with younger household members (e.g., Nkedianye et al. 2009). Household size affects the number of livelihood strategies pursued (e.g., Fabusoro et al. 2010). In this study, we evaluate how different types of human capital impact overall decisions to adapt. Perz (2005) finds significant contributions of households' wealth to non-agricultural income. Cunguara et al. (2011) finds positive impacts of car ownership on participation in non-farm activities. Here we use car ownership as proxy of wealth (i.e., financial/physical capital) and expect that households who own cars are more likely to adapt to changes by engaging with B and T.

Last but not least, 'location' is broadly identified as another endowment or asset, capturing geographically comparative advantages (Van Den Berg 2010; Pender 2004). These relate to factors such as agro-climatic condition that defines agricultural potential (e.g., Pender 2004; Adi 2007), access to roads and market that better position households to set up private entrepreneurship (e.g., Abdulai and CroleRees 2001) and contemporary investments of the government as well as organizations that advocate particular livelihoods (e.g., Smith et al. 2001). It is already evident from Table 1 that households living in different villages opt for different adaptation strategies depending on the respective agro-climatic and socio-economic settings, and we expect this to be visible in adaptation choices.

4. Econometric methods and survey design

4.1. Modelling method

With the aim to analyse the discrete choices made by individual households, we base the analysis on the random utility framework proposed by McFadden (1974). The utility that each household *n* derives from alternative *j* in choice situation *t*, named U_{njt} is contingent upon both the deterministic (V_{njt}) and stochastic (ε_{njt}) component of the utility:

$$U_{njt} = V_{njt} + \varepsilon_{njt} = \beta X_{njt} + \varepsilon_{njt} \quad (1)$$

V_{njt} is observed and consists of a vector of measurable variables X_{njt}, and associated parameters β, which characterise the individual households' preferences. ε_{njt} is unobservable and captures the factors that influence U_{njt} but are not accommodated in V_{njt} due to imperfect information.

Each household is assumed to choose the alternative that provides the highest utility after considering the full choice set in each situation. An assumption of identical independent (IID) type I extreme value distributions (EVI) for ε_{njt} gives rise to the Multinomial Logit (MNL) model. The probability of household *n* choosing alternative *j* in scenario *t* is:

$$P_{njt} = \exp\left(\beta X_{njt}\right) / \sum_{j=1}^{J} \exp\left(\beta X_{njt}\right) \quad (2)$$

To allow for heterogeneity in adaptation preferences across households, we adopt a Mixed Logit (MXL) model (Ben-Akiva et al. 2001; Brownstone and Train 1998; Train 2003). In this model the error components, denoted as W_{nm}, are assumed normally distributed with zero mean, and appear as $M \leq J$ random effects:

$$U_{njt} = \beta X_{njt} + \varepsilon_{njt} + c_{j1} W_{n1} + c_{j2} W_{n2} + \ldots + c_{jM} W_{nM} \quad (3)$$

Where m = 1,…, M, $M \leq J$ and c_{jm} = 1 if error component *m* appears in utility function *j*. Below Equation (3) is rewritten including error components:

$$P_{njt} = \exp\left(\beta X_{njt} + \sum_{m=1}^{M} C_{jm} W_{nm}\right) / \sum_{j=1}^{J} \exp\left(\beta X_{njt} + \sum_{m=1}^{M} C_{jm} W_{nm}\right) \quad (4)$$

To allow for geographical heterogeneity in terms of the variance of the estimation, we further introduced scale parameters for three village groups in the MXL model.

Therefore, $$P_{njt} = \exp\left(\beta' X_{njt} + \sum_{m=1}^{M} C_{jm} W_{nm}\right) / \sum_{j=1}^{J} \exp\left(\beta' X_{njt} + \sum_{m=1}^{M} C_{jm} W_{nm}\right) \quad (5)$$

where $\beta' = \beta / \mu_k$, k = 1, 2, 3. For estimation purposes, the scale associated with Xihu village was set to 1 as the reference.

4.2. Survey and experimental design

The levels of the possible changes were determined *a priori*, building on focus group discussions in the study area (Table 2). We asked households to describe their previous experience with climate and policy changes in the study area, including their reactions to impacts. We found that the majority of households perceived extreme climate events to occur more often now than earlier, e.g. hailstorm and drought resulting in crop loss and income reduction. They also believed that the trend could lead to longer-term climatic and ecosystem changes (Zheng and Bye, 2014). They also described their experiences with past policy changes and how that affected economic life. Following this, they were explained that these sources may keep inducing changes in the future, bringing uncertain consequences to their life.

Based on this, in the questionnaire we presented to them different sets of scenarios of income changes constructed to reflect long-term impacts of future climate and policy changes in the area. Specifically, we described how A and T activities are particularly sensitive to climate change given their natural-resource-based nature (Xiao et al. 2011), while B and C are mainly sensitive to national and global economic developments. Having introduced this context to households, we presented to them a number of choice sets asking how they would expect to change their livelihoods because of such permanent changes.

Table 2 Attributes and levels of hypothetical scenarios of changes

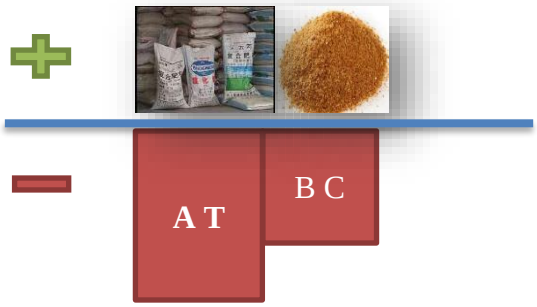
Potential influence of climate change on agriculture (A) and tourism (T) (INC_AT)	Potential influence of market on migrant work (C) and business (B) (INC_BC)	Potential government support for livelihood change
Income increases by 30% (= 0.3)	Income increases by 50% (= 0.5)	Agricultural inputs support (0 = No, 1= Yes)
Income stays the same (= 0)	Income stays the same (= 0)	Access to credit (0 = No, 1= Yes)
Income decreases by 50% (=-0.5)	Income decreases by 30% (=-0.3)	Welfare benefits for migrant workers (0 = No, 1= Yes)

We adopted a fractional factorial design optimized for d-efficiency by the use of the design software Ngene for an MNL model with 18 choices distributed to 6 blocks. Thus, each household received a questionnaire consisting of 3 scenarios. Each scenario varied in terms of outcome of the four livelihood strategies (see Fig. 1 for an example). To facilitate understanding of each question, we

showed each household a choice card illustrating the scenario and explained the meaning of it before they made their choices in each case. They were asked whether, given the changes, they would like to invest *more* efforts (e.g., labour, money, time) in either one or two of the four livelihood sectors (i.e., A, B, C, T), if neither Status-quo (S) nor Permanent migration (PM) (i.e., move and settle outside the village) was considered. We also took note of the argument households gave for their choices.

Scenario 1

- Incomes from A and T decrease by 50%
- Incomes from C and B decrease by 30%
- Subsidies for seeds, fertilizers, fodder available



- Under this circumstance, would your household:

1. ☐Stay in status quo (S)
(If no, proceed to choice 2)
2. ☐Permanent migration (PM)
(If no, proceed to choice 3)
3. ☐Allocate more efforts (e.g. labour, money, time) in _____ (select one or two from A.T.C.B)

Please indicate why your household made such choices_____

Fig. 1 An example of the choice task in the questionnaire

4.3. Sampling method

In 2012 we gathered data from 162 households (about 50% of all households in the area), randomly sampled from registers of each village depending on its population size. We conducted face-to-face interviews with household heads using trained local assistants in Naxi dialect following a structured questionnaire.

5. Results

5.1. Household characteristics and choices of livelihood adaptation

Age of household heads varied little across villages, whereas the other asset holdings including household size, farmland, education, car ownership and household income (gross income and incomes from specific livelihood sectors) differed significantly [2] (Table 3).

Table 3 Summary of characteristics of sampled households

Household characteristics	Xihu (n = 32)	Wuzubi (n = 54)	Wenhai (n = 76)
Total annual income (Yuan)	25,722 (18,990)	43,564 (32,477)	16,338 (15,874)
Agriculture income (Yuan)	12,816 (8,811)	32,582 (26,239)	7,600 (7,330)
Business income (Yuan)	2,938 (9,523)	8,204 (21,676)	2,355 (10,201)
Migrant work income (Yuan)	1,688 (4,125)	2,741 (8,599)	4,188 (6,303)
Tourism income (Yuan)	7,969 (9,732)	0 (0)	1,112 (1,938)
Age of household head (yrs)	46.3 (9.6)	47.9 (9.0)	47.1 (10.4)
Household size (no.)	4.6 (1.1)	4.3 (1.2)	4.0 (1.4)
Education level (Household head)	2.6 (0.8)	3.0 (1.0)	2.2 (1.1)
Land farmed (mu)	6.5 (2.2)	27.0 (9.0)	8.3 (4.8)
Car ownership (one and more) (%)	6.3	46.3	13.2

Note: Standard deviations in parenthesis.

5.2. Model estimation results

To investigate how socio-economic status of households relates to adaptation choices, we have set the utility for status quo to zero. We assume that households perceive scenarios and make decisions based on considerations of livelihoods already practised. Unlike agriculture (only 2% of households are without agriculture income), perceived income effects of non-farm alternatives the household currently do not practise were captured and estimated using means, recognizing that not all sampled households have participated in all types of non-farm livelihoods (i.e., current non-farm incomes take on a zero value for 38% of households) (Table 4; see Appendix A for utility specifications).

[2] We have not included gender of the household head as males predominate in the study area (95.06%). Therefore, there is hardly any variation in this aspect.

Table 4 Assumptions about parameters to be estimated in the Mixed Logit model

Variables	Description	Parameters	Assumed to share positive impacts on:	Assumed to share negative impacts on:	Assumed to share unknown impacts on:
AG_SUPPORT (relative to MIG_SUPPORT)	Availability of government support on agriculture: 0=No 1=Yes	$\beta_{AGSUPPORT\_P}$	A, B, T, A&B, A&T		
		$\beta_{AGSUPPORT\_N}$		C	
		$\beta_{AGSUPPORT\_M}$			A&C, B&C
CREDIT (relative to MIG_SUPPORT)	Availability of government support on access to credit: 0=No 1=Yes	β_{CREDIT_P}	A, B, T, A&B, A&T		
		β_{CREDIT_N}		C	
		β_{CREDIT_M}			A&C, B&C
AG_LAND	Farmland available for the household [mu]	β_{AGLAND_P}	A, B, A&B		
		β_{AGLAND_N}		C	
		β_{AGLAND_M}			T, A&C, A&T, B&C
AGE	Age of the household head [years]	β_{AGE}		A, B, C, T, A&B, A&C, A&T, B&C	
EDU	Education level of the household head: 0=Illiterate 1=Literate no formal school 2=Primary school 3=Secondary school 4=High school 5=Vocational 6=College/University or above	β_{EDU}	A, B, C, T, A&B, A&C, A&T, B&C		
SIZE	Household size: total number of individuals within each family [persons]	β_{SIZE_SINGLE}	A, B, C, T		
		$\beta_{SIZE\_COMBINED}$	A&B, A&C, A&T, B&C		
CAR	Car ownership: 0=No 1=Yes	β_{CAR_P}	B, T		
		β_{CAR_M}			A, C, A&B, A&C, A&T, B&C
MIDLAND (relative to LOWLAND)	Whether households reside in the Wuzubi village: 0=No 1=Yes	$\beta_{MIDLAND}$		A, B, C, T, A&B, A&C, A&T, B&C	
HIGHLAND (relative to LOWLAND)	Whether households reside in the Wenhai village: 0=No 1=Yes	$\beta_{HIGHLAND\_P}$	A, C, T, A&C, A&T		
		$\beta_{HIGHLAND\_M}$			A&B, B, B&C

Note: 1hectare = 15mu

The MXL model was estimated using Pythonbiogeme (Bierlaire 2003). We adopted the CFSQP [3] optimization algorithms using 500 Halton draws for estimation. As each household has 3 scenario questions to answer, ideally, there should be 486 stated choices (162*3) all together. However, we eliminated one household (equal to three choices) and a few households did not adequately respond to all three choices. Thus, 476 choices from 161 households were used for the Mixed Logit Model as is shown in Table 4.

As is shown in Table 5, the alternative specific constants (ASCs) for B, A&B, A&C and B&C are statistically significant with relatively large negative values. This indicates greater dis-utility of these adaptation strategies relative to status quo, *ceteris paribus*. Regarding the scenario variables, increases in agricultural income has a significant negative impact on the likelihood of choosing non-farm livelihoods (β_{AC_B}, β_{AC_C}, β_{AC_T} and β_{AC_BC}). Increasing income from B, C and T increases the likelihood of households investing in these activities. This is both households who do not currently have these activities ($\beta_{BC\_B\_without}$, $\beta_{CC\_C\_without}$ and $\beta_{TC\_T\_without}$) and households who currently engage in C and T activities ($\beta_{CC\_C\_with}$ and $\beta_{TC\_T\_with}$). Increasing income from circular migration, C, appears to boost likely participation in T (β_{CC_T}), and discourage the choice A&B (β_{CC_AB}). Increasing T income tend to decrease the probability of choosing A (β_{TC_A}). The provision of agriculture support (relative to welfare benefits for migrant workers) increases the livelihood of choosing all alternatives ($\beta_{AGSUPPORT\_P}$, $\beta_{AGSUPPORT\_M}$ and $\beta_{AGSUPPORT\_N}$). Access to credit facilitates choices of all means of adaptation (β_{CREDIT_P} and β_{CREDIT_M}), but C.

Echoing the hypotheses, the significant positive impacts of farmland (β_{AGLAND_P}) and car ownership (β_{CAR_P}) affect the likelihood of choosing specific livelihood alternatives. Similarly, household size (β_{SIZE_SINGLE} and $\beta_{SIZE\_COMBINED}$) affects choice of adaptations, *ceteris paribus*. Particularly, the larger value of $\beta_{SIZE\_COMBINED}$ compared with β_{SIZE_SINGLE} indicates the tendency of larger households to adopt combined livelihood alternatives as a means of adaptation to change.

Error components were also estimated. The panel error term (σ_{PANEL}) is highly significant, suggesting the error terms are correlated across choices made by the same household, as expected. The four non-nested error components for each of the livelihood sectors (i.e., A, B, C, T) capture unexplained

[3] We hereby acknowledge the use of the CFSQP routines. It is the version written in C of the Feasible Sequential Quadratic Programming algorithm developed by E.R. Panier, A.L. Tits, J.L. Zhou, and C.T. Lawrence and distributed by aemDesign.

variation associated with each livelihood pattern (σ_A, σ_B, σ_C, σ_T), and we find this is significant in for A, B and C. Third, we constructed one combined error component for the alternatives A&B, A&C, A&T and B&C (σ_{MIX}), and the significant coefficient suggests that mixed strategies have a wider distribution of unobserved preference heterogeneity. The scale parameters associated with Wuzubi (μ_{wuzubi}) and Wenhai (μ_{wenhai}) village groups are highly significant, suggesting that stated choices of livelihood adaptation are more random in the lowland compared to the other two villages.

Table 5 Parameter estimates of the Mixed Logit model

Parameters	Coefficient	Robust t statistic	Parameters	Coefficient	Robust t statistic
ASC_A	-0.976	-0.82	$\beta_{TC\_T\_without}$	1.17 **	2.08
ASC_B	-2.86 **	-2.13	β_{TC_AB}	0.102	1.02
ASC_C	-0.260	-0.21	β_{TC_AC}	-0.132	-1.33
ASC_T	-1.96	-1.58	β_{TC_BC}	-0.138	-1.27
ASC_AB	-3.61 **	-2.32	$\beta_{AGSUPPORT\_P}$	1.82 ***	3.19
ASC_AC	-2.83 *	-1.96	$\beta_{AGSUPPORT\_N}$	0.751 *	1.95
ASC_AT	-1.85	-1.44	$\beta_{AGSUPPORT\_M}$	1.95 ***	3.19
ASC_BC	-3.86 **	-2.48	β_{CREDIT_P}	1.60 ***	2.99
β_{AC_A}	0.193	1.03	β_{CREDIT_N}	-0.335	-0.61
β_{AC_B}	-0.612 *	-1.70	β_{CREDIT_M}	1.30 **	2.32
β_{AC_C}	-1.11 **	-2.22	β_{AGLAND_P}	0.661 **	1.91
β_{AC_T}	-0.693 **	-2.01	β_{AGLAND_N}	-0.317	-0.92
β_{AC_BC}	-0.956 **	-2.19	β_{AGLAND_M}	0.0751	0.25
β_{BC_A}	-0.778	-1.23	β_{AGE}	-0.347	-1.64
$\beta_{BC\_B\_with}$	0.199	0.87	β_{EDU}	0.193	1.04
$\beta_{BC\_B\_without}$	1.16 *	1.80	β_{SIZE_SINGLE}	0.325 **	2.01
β_{BC_C}	-0.815	-1.61	$\beta_{SIZE\_COMBINED}$	0.485 **	2.47
β_{BC_T}	-0.571	-1.08	β_{CAR_P}	1.24 **	2.04
β_{BC_AC}	-0.928	-1.61	β_{CAR_M}	0.433	0.80
β_{BC_AT}	-0.271	-0.56	$\beta_{MIDLAND}$	-1.70	-1.53
β_{CC_A}	0.103	0.17	$\beta_{HIGHLAND\_P}$	0.583	1.13
β_{CC_B}	0.87	1.27	$\beta_{HIGHLAND\_M}$	0.003	0.00
$\beta_{CC\_C\_with}$	2.02 **	2.36	σ_{PANEL}	1.31 **	2.81
$\beta_{CC\_C\_without}$	1.38 **	2.77	σ_A	-0.716 **	-2.27
β_{CC_T}	1.66 *	1.77	σ_B	0.993 *	1.68
β_{CC_AB}	-1.89 *	-1.71	σ_C	0.529 *	1.81
β_{CC_AT}	0.0239	0.03	σ_T	-0.0751	-1.14
β_{TC_A}	-0.118 *	-1.80	σ_{MIX}	-0.531 *	-1.73
β_{TC_B}	-0.138	-0.96	μ_{wuzubi}	1.16 **	2.69
β_{TC_C}	-0.147	-0.98	μ_{wenhai}	1.44 ***	2.87
$\beta_{TC\_T\_with}$	0.433 **	2.81			
Number of observations	476				
Loglikelihood	-760.466				
LR chi-square	41.363 ***				
Pseudo-R^2	0.2136				

Notes: Scaled data were used to estimate the models in order to shorten the running time. The scenario variables including income changes of agriculture, business and migrant work were divided by 10^4 and income change of tourism was divided by10^3.Variables of agriculture land and age were divided by 10. ***: p<0.01; **: p<0.05; *: p<0.1.

6. Discussion

6.1. Choices of livelihood adaptation

In our case study, agriculture is the backbone of households' livelihood and they remain faithful to it in their adaptation to most of the possible scenarios of changes described to them. The fact that households are prone to choose adaptation actions reflecting their current activities might indicate the use of heuristics (Patt 2007; Patt and Zeckhauser 2000; Payne et al. 1993). Our results show that in the face of change households are, *ceteris paribus*, likely to choose investments in livelihood portfolios they are familiar with, as reflected in the significantly negative ASCs of business and combined livelihood alternatives (except A&T). Conversations with farmers during fieldwork revealed their appreciation of what they already have. On the other hand, their choices may reflect uncertainty related to the hypothetical decision-settings (Samuelson and Zeckhauser 1988; Kahneman et al. 1991; Kahneman and Tversky 1979). As households respond to hypothetical scenarios, the extent to which they are convinced of the outcomes presented to them is a source of uncertainty (Patt et al. 2010). A further possible reason for the preference for familiar trades may be unobserved elements of utility, such as comfort and happiness, and their attachment to tradition and culture identity. The majority of households recognised themselves as farmers and took 'working with the land' as their principal occupation.

6.2. Responsiveness to changes

We also found a propensity of households willing to adopt livelihood portfolios beyond agricultural activities. These choices increased in likelihood when agricultural income was predicted to decrease or when alternatives included improved opportunities in non-agricultural livelihoods. Of particular interest is the finding that households can be induced to adopt transformative adaptation; namely to take up completely new livelihood activities which they have not already practised ($\beta_{BC\_B\_without}$, $\beta_{CC\_C\_without}$ and $\beta_{TC\_T\_without}$). These positive responses reflect a will to innovate among households and hold promise for policies intended to support livelihood diversification.

Our analysis further reveals that policies enhancing the availability of agricultural support increase likelihood of adaptation through increased efforts in agriculture. Policies supporting agricultural activities are also found to have positive impacts on investments in other non-agriculture livelihoods, which may be explained by the positive inter-sectorial linkages perceived by households (Barrett et al. 2001). The labour or capital resources freed from higher productivity in agriculture may provide

a better precondition for households to participate in migrant work and to take on the higher costs and risks associated with this activity.

The significant impact of access to credit on the willingness to pursue adaptation in several livelihood sectors (except C) underscores its crucial role in removing entry barriers, providing working capital for purchasing viable inputs (such as seedlings, livestock), and allowing for investments (such as cars/trucks) essential to achieve self-employment and establish micro enterprises (Rakodi 1999). We found that assets held affected stated adaptation decisions. Households possessing richer farmland were more likely to select alternatives A and B. Households who owned cars were more likely to adopt B and T. We also found that larger households were more likely to choose combined alternatives. We found no significant positive influence of higher education on facilitating adaptation, which we would have expected. One possible explanation may be the rather homogeneous education profile of household heads in the study fields, with the majority having attended primary or secondary school (70%). Moreover, certain livelihoods (particularly non-agricultural sectors) may require practical skills and competencies rather than actual education. For example, some households considered tourism a challenge due to 'Mandarin-deficiency' and shyness, and transportation was only considered by those who knew how to drive.

6.3. Implications for policies

The finding that households have a strong preference for adapting with increasing efforts in trades where they are already active may not be surprising by itself. However, it may be a source of concern as it could seriously delay suitable adaptation behaviour to e.g., climate change or significant structural changes in the economy. This suggests room for policy interventions, and our findings suggest several possibilities for policies to facilitate adaptation. In particular, credit and asset provision can be vital for households to manage possible climate change induced agricultural failures or to take advantage of the benefits emerging from non-agriculture sectors. This has support in the rural development literature, where non-farm livelihoods are recognised as critical apparatus to administer risk, enhance security and well-being and reduce vulnerability (Ellis 1998). In addition, strategies targeting the improvement of households' practical skills (e.g., speaking Mandarin or other languages, driving) may overcome significant obstacles for households to undertake particular livelihoods and strengthen their capacity to adapt.

6.4. Limitations of the study

We adopted a CE to operationalise households' livelihood likely responses to possible scenarios of changes. This approach has a few limitations. First, the formulation of hypothetical scenarios calls for some level of simplification and is inevitably imperfect. Hence, we are aware that e.g. another way of framing may have led to somewhat different results. Nevertheless, the results are valid within the framing and the case study setting they represent. Moreover, the application in focus here is to *strategic* livelihood responses to *permanent change*, as compared to short-term adjustments to climatic or market variability. In such a context, the result of preference for current livelihoods, although not surprising, may deserve further thoughts in actual adaptation policies.

Second, the hypothetical nature and stated preference mean that external validity concerns are justified regarding their predictive power for actual behavioural change. However, this cannot be otherwise for *ex ante* adaptation analyses. Third, the study focuses on sector-based livelihood adaptations. While this is useful for strategic adaptation planning over larger geographic areas, the results are constrained by the set of sectors included and cannot reveal much of how adaptation may change practices within each sector. Finally, we have not considered the impacts of subjective factors on adaptation preferences. This opens room for future research, which could enrich the behavioural model by accommodating variables that for instance reflect personality attributes (e.g., attitudes towards life).

7. Conclusion

We applied a CE to study rural households' stated choice of adaptation under scenarios of climate and policy changes. The approach, with its strengths and limitations, provides a useful tool to frame adaptation decisions within the random utility theory framework and allows us to examine in-depth the quantifiable effects of various changes and components of households' adaptive capacity through investigating the likelihood of them choosing changed effort in different livelihood strategies. By looking at adaptation preferences among households in three mountain communities of Lijiang, Yunnan, China, the study also provides a good starting point to integrate detailed and localised information, gathered from a 'bottom-up' process, into adaptation planning.

Overall, we find households to prefer increased effort in their current trades, mainly agriculture, as a primary adaptation means, and we document a strong tendency to adhere to status-quo strategies.

However, we also find that certain changes, e.g. decreases in future agricultural income, and policy measures, e.g. credit access, may increase households' willingness to adapt through diversifying into or switching resources to non-agricultural sectors like business, tourism and circular migration work.

To better prepare the households for the future, the analysis has brought to the forefront the need to cautiously balance and develop both agriculture and non-agriculture livelihoods. The results also point to various policy instruments that can build up adaptive capacity of rural households and foster adaptation. Such measures could focus on e.g. providing access to credit as well as practical skills training. Acknowledging the dynamic nature of adaptation, our analysis is by no means exhaustive and results are to be interpreted with regard to its case study context. Nevertheless, we demonstrate how CE can be applied to inform *ex ante* possible adaptation behaviour.

References

Abdulai A, CroleRees A (2001) Determinants of income diversification amongst rural households in Southern Mali. Food Policy 26 (4):437-452

Adger WN, Vincent K (2005) Uncertainty in adaptive capacity. Comptes Rendus Geoscience 337 (4):399-410

Adi B (2007) Determinants of agricultural and non-agricultural livelihood strategies in rural communities: evidence from eastern Nigeria. The Journal of Developing Areas 40 (2):93-109

Barrett CB (1997) Food marketing liberalization and trader entry: evidence from Madagascar. World Dev 25 (5):763-777

Barrett CB, Reardon T, Webb P (2001) Nonfarm income diversification and household livelihood strategies in rural Africa: concepts, dynamics, and policy implications. Food Policy 26 (4):315-331

Ben-Akiva M, Bolduc D, Walker J (2001) Specification, identification and estimation of the logit kernel (or continuous mixed logit) model. MIT Working Paper, Department of Civil Engineering

Berhanu W, Colman D, Fayissa B (2007) Diversification and livelihood sustainability in a semi-arid environment: a case study from southern Ethiopia. J Devel Stud 43 (5):871-889

Bierlaire M BIOGEME: A free package for the estimation of discrete choice models. In: Proceedings of the 3rd Swiss Transportation Research Conference, Ascona, Swizerland, 2003.

Brownstone D, Train K (1998) Forecasting new product penetration with flexible substitution patterns. J Econometrics 89 (1):109-129

Cinner JE, Folke C, Daw T, Hicks CC (2011) Responding to change: using scenarios to understand how socioeconomic factors may influence amplifying or dampening exploitation feedbacks among Tanzanian fishers. Glob Environ Chang 21 (1):7-12

Cunguara B, Langyintuo A, Darnhofer I (2011) The role of nonfarm income in coping with the effects of drought in southern Mozambique. Agr Econ 24 (6):701-713

Dearing JA, Braimoh AK, Reenberg A, Turner BL, van der Leeuw S (2010) Complex land systems: The need for long time perspectives to assess their future. Ecol Soc 15 (4):21

Dercon S (2002) Income risk, coping strategies, and safety nets. World Bank Res Obs 17 (2):141-166

Ellis F (1998) Household strategies and rural livelihood diversification. J Dev Stud 35 (1):1-38

Eneyew A (2012) Determinants of livelihood diversification in pastoral societies of southern Ethiopia. Journal of Agriculture and Biodiversity Research 1 (3):43-52

Evans LS, Hicks CC, Fidelman P, Tobin RC, Perry AL (2013) Future Scenarios as a Research Tool: Investigating Climate Change Impacts, Adaptation Options and Outcomes for the Great Barrier Reef, Australia. Hum Ecol 41 (6):841-857. doi:10.1007/s10745-013-9601-0

Fabusoro E, Omotayo A, Apantaku S, Okuneye P (2010) Forms and determinants of rural livelihoods diversification in Ogun State, Nigeria. J Sustainable Agric 34 (4):417-438

Freeman , AM, 2003. The measurement of environmental and resource value: Theory and methods (2nd ed.) Washington, DC: Resources for the Future.

Freier KP, Bruggemann R, Scheffran J, Finckh M, Schneider UA (2012) Assessing the predictability of future livelihood strategies of pastoralists in semi-arid Morocco under climate change. Technol Forecast Soc Change 79 (2):371-382

Gale F, Lohmar B, Tuan F (2005) China's new farm subsidies. United States Department of Agriculture Outlook, WRS-05-01. Economic Research Service, United States Department of Agriculture (USDA), Washington, D.C. Available from: http://naldc.nal.usda.gov/download/34802/PDF

Hatlebakk M (2012) Regional variation in livelihood strategies in Malawi. South African J Econ 80 (1):62-76

Kahneman D, Knetsch JL, Thaler RH (1991) Anomalies: the endowment effect, loss aversion, and status quo bias. The Journal of Economic Perspectives 5 (1):193-206
Kahneman D, Tversky A (1979) Prospect theory: an analysis of decision under risk. Econometrica 47 (2):263-291
Kassahun, HT, Jacobsen, JB, 2015. Economic and Institutional Incentives for Managing the Ethiopean Highlands of the Upper Blue Nile Basin: A Latent Class Analysis. *Land Use policy* 44, 76-89. DOI: 10.1016/j.landusepol.2014.11.017
Kassahun, HT, Nicholson, CF, Jacobsen, JB, Steenhuis, TS, 2016. Accounting for user expectations in the valuation of reliable irrigation water access in the Ethiopian highlands. Agricultural Water Management 168, 45-55. http://dx.doi.org/10.1016/j.agwat.2016.01.017
Kates RW, Travis WR, Wilbanks TJ (2012) Transformational adaptation when incremental adaptations to climate change are insufficient. Proceedings of the National Academy of Sciences 109 (19):7156-7161
Li BQ (2006) Floating population or urban citizens? Status, social provision and circumstances of rural–urban migrants in China. Soc Pol Admin 40 (2):174-195
McFadden D (1974) Conditional logit analysis of qualitative choice behavior. In: Zarembka P (ed) Frontiers in Economics. Academic Press, New York, pp 105-142
Nainggolan D, Termansen M, Reed MS, Cebollero ED, Hubacek K (2011) Farmer typology, future scenarios and the implications for ecosystem service provision: a case study from south-eastern Spain. Reg Environ Change:1-14
Nguyen, TC, Robinson, J, Kaneko, S and Komatsu, S, 2013. Estimating the value of economic benefits associated with adaptation to climate change in a developing country: A case study of improvements in tropical cyclone warning services. Ecological Economics 86: 117-128.
Nielsen, M., Jacobsen, JB, Thorsen, BJ, 2014. The choice of hunting and trading bushmeat in the Kilombero Valley, Tanzania: What reduces effort most effectively? *Conservation Biology* 28, 382-391 http://onlinelibrary.wiley.com/doi/10.1111/cobi.12197/abstract
Nielsen JO, Reenberg A (2010) Temporality and the problem with singling out climate as a current driver of change in a small West African village. J Arid Environ 74 (4):464-474
Ning BY, He YQ, He XZ, Pang HX, Yuan LL, Zhao JD, Lu AG and Song B (2006). Potential impacts of glacier retreating of the Mt. Yulong on the socioeconomic development in Lijiang City. Journal of Glaciology and Geocryology 28(6): 885-892
Nkedianye D, Radeny M, Kristjanson P, Herrero M (2009) Assessing returns to land and changing livelihood strategies in Kitengela. In: Homewood K, Kristjanson P, Trench PC (eds) Staying Maasai? Livelihoods, Conservation and Development in East African Rangelands. Studies in Human Ecology and Adaptation, vol 5. Springer, New York, pp 115-149
O'Brien KL, Leichenko RM (2000) Double exposure: assessing the impacts of climate change within the context of economic globalization. Glob Environ Chang 10 (3):221-232
Patt A (2007) Assessing model-based and conflict-based uncertainty. Glob Environ Chang 17 (1):37-46
Patt A, Zeckhauser R (2000) Action bias and environmental decisions. J Risk Uncertainty 21 (1):45-72
Patt AG, van Vuuren DP, Berkhout F, Aaheim A, Hof AF, Isaac M, Mechler R (2010) Adaptation in integrated assessment modeling: where do we stand? Clim Change 99 (3):383-402
Payne JW, Bettman JR, Johnson EG (1993) The adaptive decision maker. Cambridge University Press, Cambridge
Pender J (2004) Development pathways for hillsides and highlands: some lessons from Central America and East Africa. Food Policy 29 (4):339-367

Perz SGL (2005) The importance of household asset diversity for livelihood diversity and welfare among small farm colonists in the Amazon. J Devel Stud 41 (7):1193-1220
Rakodi C (1999) A capital assets framework for analysing household livelihood strategies: implications for policy. Development Policy Review 17 (3):315-342
Rakotonarivo, OS, Jacobsen, JB, Larsen, HO, Jones, JPG., Nielsen, MR, Ramamonjisoa, BS, Mandimbiniaina, RH, Hockley, N., 2017. Qualitative and quantitative evidence on the true local welfare costs of forest conservation in Madagascar: Are discrete choice experiments a valid ex-ante tool? World Development 94, 478-491. http://dx.doi.org/10.1016/j.worlddev.2017.02.009
Reardon T (1997) Using evidence of household income diversification to inform study of the rural nonfarm labor market in Africa. World Dev 25 (5):735-747
Reenberg A, Birch-Thomsen T, Mertz O, Fog B, Christiansen S (2008) Adaptation of human coping strategies in a small island society in the SW pacific - 50 years of change in the coupled human–environment system on Bellona, Solomon Islands. Hum Ecol 36 (6):807-819
Samuelson W, Zeckhauser R (1988) Status quo bias in decision making. J Risk Uncertainty 1 (1):7-59
Scoones I (1998) Sustainable rural livelihoods: a framework for analysis. IDS Working Paper 72. Institute of Development Studies, Brighton
Smith DR, Gordon A, Meadows K, Zwick K (2001) Livelihood diversification in Uganda: patterns and determinants of change across two rural districts. Food Policy 26 (4):421-435
Train K (2003) Discrete choice models with simulation. Cambridge University Press, Cambridge
Tschakert P, Dietrich KA (2010) Anticipatory learning for climate change adaptation and resilience. Ecol Soc 15 (2):11
Tversky A, Kahneman D (1991) Loss aversion in riskless choice: a reference-dependent model. The Quarterly Journal of Economics 106 (4):1039-1061
Valkering P, Van der Brugge R, Offermans A, Rijkens-Klomp N (2011) Scenario analysis of perspective change to support climate adaptation: lessons from a pilot study on Dutch river management. Reg Environ Change 11 (2):229-241
Van Den Berg M (2010) Household income strategies and natural disasters: dynamic livelihoods in rural Nicaragua. Ecol Econ 69 (3):592-602
Xiao L, Li X, Wang R (2011) Integrating climate change adaptation and mitigation into sustainable development planning for Lijiang City. International Journal of Sustainable Development & World Ecology 18 (6):515-522
Zheng Y, Byg A (2014) Coping with climate change: Households' response strategies to drought and hailstorm in Lijiang, China. Environmental Hazards. DOI:10.1080/17477891.2014.902799
Zheng Y, Byg A, Thorsen BJ, Strange N (2012) A temporal dimension of household vulnerability in three rural communities in Lijiang, China. Hum Ecol. doi:10.1007/s10745-013-9633-5

Appendix A Mixed Logit model specification

Let V_{jnt} denote the representative utility for alternative *j* chosen by individual household *n* in hypothetical scenario *t* (see Eq. (1) in the paper). For each non-agriculture livelihood sector, a dummy was created to differentiate households who have already practised that livelihood from those who don't (e.g., WITH_BINCOME vs. NO_BINCOME). INC_AT and INC_BC represent the level of income changes of different livelihood sectors in the hypothetical scenarios (see Table 2). Income change variable for a specific livelihood sector was calculated as the product of households' current income of that sector and the level of change (e.g., AC_INCOME = A_INCOME * INC_AT).

The utilities for the alternatives of A, B, C, T, A&B, A&C, A&T and B&C (numbered from 1 to 8 in sequence) are given by:

$$V_1 = ASC\_A + \beta_{AC\_A} * AC\_INCOME + \beta_{BC\_A} * BC\_INCOME + \beta_{CC\_A} * CC\_INCOME + \beta_{TC\_A} * TC\_INCOME + \beta_{CREDIT\_P} * CREDIT + \beta_{AGSUPPORT\_P} * AG\_SUPPORT + \beta_{MIDLAND} * MIDLAND + \beta_{HIGHLAND\_P} * HIGHLAND + \beta_{AGE} * AGE + \beta_{EDU} * EDU + \beta_{CAR\_M} * CAR + \beta_{AGLAND\_P} * AG\_LAND + \beta_{SIZE\_SINGLE} * SIZE + \sigma_A + \sigma_{PANEL} \quad \text{Eq. (A.1)}$$

$$V_2 = ASC\_B + \beta_{AC\_B} * AC\_INCOME + \beta_{BC\_B\_with} * BC\_INCOME * WITH\_BINCOME + \beta_{BC\_B\_without} * INC\_BC * NO\_BINCOME + \beta_{CC\_B} * CC\_INCOME + \beta_{TC\_B} * TC\_INCOME + \beta_{CREDIT\_P} * CREDIT + \beta_{AGSUPPORT\_P} * AG\_SUPPORT + \beta_{MIDLAND} * MIDLAND + \beta_{HIGHLAND\_M} * HIGHLAND + \beta_{AGE} * AGE + \beta_{EDU} * EDU + \beta_{CAR\_P} * CAR + \beta_{AGLAND\_P} * AG\_LAND + \beta_{SIZE\_SINGLE} * SIZE + \sigma_B + \sigma_{PANEL} \quad \text{Eq. (A.2)}$$

$$V_3 = ASC\_C + \beta_{AC\_C} * AC\_INCOME + \beta_{BC\_C} * BC\_INCOME + \beta_{CC\_C\_with} * CC\_INCOME * WITH\_CINCOME + \beta_{CC\_C\_without} * INC\_BC * NO\_CINCOME + \beta_{TC\_C} * TC\_INCOME + \beta_{CREDIT\_N} * CREDIT + \beta_{AGSUPPORT\_N} * AG\_SUPPORT + \beta_{MIDLAND} * MIDLAND + \beta_{HIGHLAND\_P} * HIGHLAND + \beta_{AGE} * AGE + \beta_{EDU} * EDU + \beta_{CAR\_M} * CAR + \beta_{AGLAND\_N} * AG\_LAND + \beta_{SIZE\_SINGLE} * SIZE + \sigma_C + \sigma_{PANEL} \quad \text{Eq. (A.3)}$$

$$V_4 = ASC\_T + \beta_{AC\_T} * AC\_INCOME + \beta_{BC\_T} * BC\_INCOME + \beta_{CC\_T} * CC\_INCOME + \beta_{TC\_T\_with} * TC\_INCOME * WITH\_TINCOME + \beta_{TC\_T\_without} * INT\_AT * NO\_TINCOME + \beta_{CREDIT\_P} * CREDIT + \beta_{AGSUPPORT\_P} * AG\_SUPPORT + \beta_{MIDLAND} * MIDLAND + \beta_{HIGHLAND\_P} * HIGHLAND + \beta_{AGE} * AGE + \beta_{EDU} * EDU + \beta_{CAR\_P} * CAR + \beta_{AGLAND\_M} * AG\_LAND + \beta_{SIZE\_SINGLE} * SIZE + \sigma_T + \sigma_{PANEL} \quad \text{Eq. (A.4)}$$

V_5 = ASC_AB + β_{AC_A} * AC_INCOME + $\beta_{BC\_B\_with}$ * BC_INCOME * WITH_BINCOME + $\beta_{BC\_B\_without}$ * INC_BC * NO_BINCOME + β_{CC_AB} * CC_INCOME + β_{TC_AB} * TC_INCOME + β_{CREDIT_P} * CREDIT + $\beta_{AGSUPPORT\_P}$ * AG_SUPPORT + $\beta_{MIDLAND}$ * MIDLAND + $\beta_{HIGHLAND\_M}$ * HIGHLAND + β_{AGE} * AGE + β_{EDU} * EDU + β_{CAR_M} * CAR + β_{AGLAND_P} * AG_LAND + $\beta_{SIZE\_COMBINED}$ * SIZE + σ_A + σ_B + σ_{MIX} + σ_{PANEL} Eq. (A.5)

V_6 = ASC_AC + β_{AC_A} * AC_INCOME + β_{BC_AC} * BC_INCOME + $\beta_{CC\_C\_with}$ * CC_INCOME * WITH_CINCOME + $\beta_{CC\_C\_without}$ * INC_BC * NO_CINCOME + β_{TC_AC} * TC_INCOME + β_{CREDIT_M} * CREDIT + $\beta_{AGSUPPORT\_M}$ * AG_SUPPORT + $\beta_{MIDLAND}$ * MIDLAND + $\beta_{HIGHLAND\_P}$ * HIGHLAND + β_{AGE} * AGE + β_{EDU} * EDU + β_{CAR_M} * CAR + β_{AGLAND_M} * AG_LAND + $\beta_{SIZE\_COMBINED}$ * SIZE + σ_A + σ_C + σ_{MIX} + σ_{PANEL} Eq. (A.6)

V_7 = ASC_AT + β_{AC_A} * AC_INCOME + β_{BC_AT} * BC_INCOME + β_{CC_AT} * CC_INCOME + $\beta_{TC\_T\_with}$ * TC_INCOME * WITH_TINCOME + $\beta_{TC\_T\_without}$ * INT_AT * NO_TINCOME + β_{CREDIT_P} * CREDIT + $\beta_{AGSUPPORT\_P}$ * AG_SUPPORT + $\beta_{MIDLAND}$ * MIDLAND + $\beta_{HIGHLAND\_P}$ * HIGHLAND + β_{AGE} * AGE + β_{EDU} * EDU + β_{CAR_M} * CAR + β_{AGLAND_M} * AG_LAND + $\beta_{SIZE\_COMBINED}$ * SIZE + σ_A + σ_T + σ_{MIX} + σ_{PANEL} Eq. (A.7)

V_8 = ASC_BC + β_{AC_BC} * AC_INCOME + $\beta_{BC\_B\_with}$ * BC_INCOME * WITH_BINCOME + $\beta_{BC\_B\_without}$ * INC_BC * NO_BINCOME + $\beta_{CC\_C\_with}$ * CC_INCOME * WITH_CINCOME + $\beta_{CC\_C\_without}$ * INC_BC * NO_CINCOME + β_{TC_BC} * TC_INCOME + β_{CREDIT_M} * CREDIT + $\beta_{AGSUPPORT\_M}$ * AG_SUPPORT + $\beta_{MIDLAND}$ * MIDLAND + $\beta_{HIGHLAND\_M}$ * HIGHLAND + β_{AGE} * AGE + β_{EDU} * EDU + β_{CAR_M} * CAR + β_{AGLAND_M} * AG_LAND + $\beta_{SIZE\_COMBINED}$ * SIZE + σ_B + σ_C + σ_{MIX} + σ_{PANEL} Eq. (A.8)