Perception of climate change and adaptation strategies in Vietnam

Are there intra-household gender differences?

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Abstract

Purpose – The purpose of this study is to first examine the factors affecting the intra-household perception of climate change. Second, the study investigates the impact of the perception of climatic stress on the operators' and spouses' intra-household adaptation strategies (farm and household financial strategies).

Design/methodology/approach – The study uses household survey data from Vietnam's Mekong Delta. The study uses probit and negative binomial count data approaches to evaluate the empirical model.

Findings – Results confirm the existence of intra-household gender differences in the adaptation strategies. The authors found that although spouses perceive climatic stress, they are less likely to adapt to such stresses when it comes farming enterprise, but more likely to adapt to household financial strategies. In contrast, farm operators, in the presence of climatic stresses, undertake both farm and household finance adaptation strategies.

Practical implications – Investment in climate smart agriculture can help households in managing climatic stresses.

Originality/value – A farmer in Asia, and Vietnam in particular, faces significant risks from climatic changes. In Vietnam, agriculture is easily affected by natural disasters and climatic changes. This study provides insights into the perception of climatic changes by operators and spouses in Vietnam's Mekong Delta. Perceived changes in the climate have a greater impact on women because they typically lack the necessary tools to adapt to climate change. The current findings could be useful in managing climatic risk in Vietnam's Mekong Delta and be helpful to policymakers in designing risk management strategies in response to climatic changes.

Keywords Gender, Climate change, Adaptation strategies, Farming enterprises, Financial strategies

Paper type Research paper

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1. Introduction

The reunification of North and South Vietnam led to an economic crisis, including food shortage, low productivity and high inflation. In response, Vietnam's government began a process of economic reforms, known as *doi moi* reforms, in the late 1980s that spurred market development in Vietnam. As a result, Vietnam experienced rapid market development in the 1990s (Levinson and Christensen, 2002). These policies have contributed to an average annual growth rate of 6.4 per cent per year in the 2000s, coupled with a dramatic reduction in poverty[1] from 50 to 3 per cent between the early 1990s and 2015 (World Bank, 2016). In low-income countries, such as Vietnam, agriculture accounts for 20 per cent of the gross domestic product and contributes to about 44 per cent of the agricultural labor and 69 per cent of the rural labor force. The rapid growth in the agricultural sector, particularly the rice sector, has served as the foundation for Vietnam's successful development story.

However, growth in the agricultural sector, particularly in rice, in the recent years has been hampered by:

- higher inputs costs;
- overuse of fertilizer and pesticides;
- increased use of water; and
- higher labor costs (Mottaleb *et al.*, 2016).

In addition, Vietnam, and Asia in general, faces significant risks from climate change (Kim, 2011). The author notes that Asia is one of the most vulnerable regions to climate change. Additionally, according to the latest report from the Intergovernmental Panel on Climate Change (IPCC), Asia could see decreases in water supply and food production in many areas because of increased risks to coastal zones and increased exposure to more intense extreme events (IPCC, 2014). Vietnam is one of the Southeast Asian countries facing significant climate change. Vietnamese agriculture is affected by natural disasters such as flooding, drought, saltwater intrusion and torrential rains and typhoons (ADB, 2010; Smyle and Cooke, 2014); as a result, crop yield could be reduced[2]. In particular, 31 per cent of the Mekong Delta (our area of study), a major agricultural region of Vietnam, is predicted to be inundated with a up to 1-m rise in the sea level (Carew-Reid, 2008). Lobell *et al.* (2011) stress that the impact of climate change on crop yield has already been detected in the observed data. Hence, climate change can lead to increased risks to agricultural production and, consequently, risks to food security. The Mekong Delta has been identified to be significantly vulnerable to climate change. Although the Mekong Delta represents a major rice-producing region in the country, it is still vulnerable to the challenges of rising sea levels, causing salinity intrusion into agricultural lands (Smajgl *et al.*, 2015; Thuy and Anh, 2015). This climatic stress is actually more severe in the Mekong Delta than in the other regions of Vietnam, and given Mekong Delta's important role in national food security and agricultural exports, the region deserves particular attention.

In many developing countries, agriculture and animal husbandry occupations are not lucrative and result in men migrating to urban areas for better jobs and incomes. This phenomenon has put women, who are left behind, in charge of the farm and agricultural production (Vij and Narain, 2016). Further, from a development perspective, women attach specific importance to food security (Smith & Haddad, 2000). Female-headed households account for 3 to 38 per cent of all households and are responsible for 2 to 17 per cent of the value of food produced in the developing countries (Doss, 2002). Additionally, within climate change discussion, the focus on the role of women is gaining momentum and rural women,

in particular, are reported to be at a greater risk of the negative impacts of climate change (Goh, 2012; Dakota *et al.*, 2011; Nellemann *et al.*, 2011). Climate change risk is also greater for women because they typically lack the necessary tools to adapt to climate change such as land rights[3], financial and material resources as well as the relevant skills to adapt to climate change (Mitchell *et al.*, 2007). In a recent study, Quisumbing *et al.* (2014) argued that agriculture is underperforming because half of the farmers – women – do not have equal access to resources and opportunities. An empowered woman who can make decisions about planting materials and inputs is more productive in agriculture. Furthermore, cultural barriers can often limit women's access to the services required to adapt to climate change (Dankelman *et al.*, 2008; Mitchell *et al.*, 2007). However, Carvajal-Escobar *et al.* (2008) note that rural women, who are playing an important role in agricultural production in several developing countries, could provide an opportunity to impact food production and food security positively, even while adapting to a changing climate. Therefore, importance should be given to the influence of gender on the ability of individuals in the farm households (farmer and spouses) to adapt to the effects of a changing climate.

Adaptation is a key response to climate change. Bryant *et al.* (2000) reported that adaptation in agriculture is how the perception of climate change is translated into the agricultural decision-making[4]. Halsnaes and Traerup (2009) found that vulnerability and adaptation strategies are linked to poverty reduction measures. Furthermore, empirical studies revealed that women and men make decisions differently. For example, Patt *et al.* (2007) noted that men are more risk-taking, whereas women tend to be more risk-averse. Men are more overconfident, thinking that they can predict and handle the future themselves, while women are more willing to adapt their strategies and behavior (Brown-Kruse and Hummels, 1993; Patt *et al.*, 2007). When it comes to climate, women's responsibilities in the family make them more vulnerable to environmental change, which is exacerbated by the impacts of climate change. As a result, gender analysis is a major step for gender-appropriate targeting of climate-smart agriculture, insurance and other risk management strategies.

There have been several studies investigating factors that affect adaptation to climate change in the agricultural sector (Adger *et al.*, 2003; Below *et al.*, 2012; Deressa *et al.*, 2011). To best of our knowledge, none have investigated the perception of climate change and adaptation strategies (farm and household financial) by farmers and spouses, individually. It is important to understand how farmers and spouses in Vietnam's Mekong Delta perceive climate change, as the coping strategies they resort to are based on their perception. Herein lies the objective of this study. First, this study assesses the factors affecting the perception of the severity of climate change (or climatic stress) by farmers and spouses, separately. Secondly, what farm and household financial adaptation strategies do farmers and spouses adopt to reduce the impact of the perceived severity of climatic stress? Several studies have investigated the role of perception in the adaptation to climate change (Deressa *et al.*, 2011; Mertz *et al.*, 2009; Patt and Schroter, 2008); none of the studies in the literature have addressed the role of gender (men and women) in the perception of climatic stress and how spouses and farmers within the same household adapt to the climatic stress in Southeast Asia. The main focus of the paper is intrahousehold gender differences in the perception of climate change severity and the resulting adaptation strategies. Even though spouses and farmers share similar household characteristics within the same families, adaptation strategies may vary between the two, particularly when distinctions are made between farm and household financial adaptation strategies.

Exploration of the gender dynamics in the context of climate change and response to climatic change through adaptation strategies, both on the farm (FAS) and in household

finances (HFAS), may be the most appropriate way to improve the level of understanding in the climate change and food security research communities. In particular, how do farmers and spouses perceive climate change or severity in climate change. Second, what farm and household risk management strategies do they adopt to reduce or mitigate the impact of the perceived climate change? Note that the adoption of risk management strategies can reduce current and future vulnerability to climate change. Our results improve our knowledge of the smallholder perception of climate change in Vietnam's Mekong Delta and can be used by policymakers seeking to improve adaptation processes and outcomes.

2. Conceptual framework

In the early 2000s, Grothmann and Patt (2005) concluded that a misconception about climate change and its associated risks may result in no adaptation or under-adaptation and may ultimately increase the negative impact of climate change. Recently Pauw's (2013) research underscored the importance of the perception of climate change and noted that perception strongly affects how farmers deal with climate-induced risks. Furthermore, behavioral responses to this perception would shape adaptation options, the process involved and the adaptation outcomes. The underlying model assessing the perception of climate change is embedded in the psychometric (Fischhoff *et al.*, 1978; Sjöberg, 2000) and the cultural theory models (Dake, 1991; Sjöberg, 1997). Sjöberg (2000) concluded that the psychometric model is cognitive in its conception and flavor – risks are indeed perceived according to this tradition; therefore, risk perception is a function of the properties of the hazards. Additionally, the cultural theory stresses that risk perception is a reflection of the social context that an individual finds him- or herself in. However, the perception of climate change among farming communities (interchangeably rural communities) is driven by several socioeconomic and environmental factors (Sampei and Aoyagi-Usui, 2009; Deressa *et al.*, 2011). These include farming experience, the age of the farmer, spouse, gender, household income, educational attainment, membership in environmental groups, access to media (Leiserowitz, 2006), soil type and geographical location (Maddison, 2006). An advantage of our study is that concerning the perception of climate change (=climate stress), the survey queried farmers (FO) and spouses (FS) in each household separately. Perhaps, this separation interjects the issue of gender and its perception of climate change. The authors posit that farm and household factors influence the FO and FS perception of climate change (=climatic stress) and its impact on local agriculture, mainly rice production in Vietnam's Mekong Delta.

A farmer's perception of climate change relates more to the increased variability and uncertainty of specific weather parameters than to long-term climate change (Mertz *et al.*, 2009)[5]. Some of these perceptions include the late onset of rains, shorter wet monsoon strong winds with excessive rains, more intense summer heat and unpredictability in the patterns of the seasons. In this context, only a few studies in India highlight the importance of recording the perception of climate change (Kelkar *et al.*, 2008; Vardan and Kumar, 2014). However, our study, the first of its kind, is unique in that the surveyors queried farmers and their spouses in Vietnam's Mekong Delta on the severity of climate change (stress), separately, over time[6]. Specifically, they were asked if they observed changes in the severity of climatic stresses over time. The perception of the respondent can be seen as subjective since it is based on his own judgment of how he/she sees the climatic conditions changing in his area. This subjectivity of the response fits well with the purpose of the study as the authors are interested in knowing how they adapt to climate change on the basis of their judgment of the changes in climate stresses. In the probit model for FO and FS, the perceived severity of climate stress (SCS) = 1 if it is observed; 0, otherwise.

On the basis of their perceptions, farmers devise ways of adapting to climate change. Banerjee *et al.* (2013) note that adaptation includes adjustments or actions taken to maintain the capacity to deal with climatic stresses, caused by current and future external changes in climate. Füssel (2007) noted that adaptation should be emphasized because human activities are already affecting climate; adaptation can be undertaken at the local or national level. Interestingly, our study emphasizes individual action. Nonetheless, adaptation to climate change is a two-step process; the first step requires the farmers to perceive a change in climate, and the second phase requires them to act through adaptation (Maddison, 2006). Adaptation reduces adverse impacts of climate change (Thomas *et al.*, 2007). There are several ways of adapting to climate change in agriculture. These include crop choices, land allocation, livestock diversity, planting varieties of the same crop, changing the planting dates, increased use of irrigation and water and soil conservation techniques. Different factors affect the use of any of the above adaptation methods (Mertz *et al.*, 2009; Kurukulasuriya and Mendelson, 2006; Apata *et al.*, 2009).

Interestingly, in this study, the authors focus on two adaptation strategies. They include adaptation strategies concerning farming[7] and household/finances[8]. Here, the authors hypothesize that gender plays a major role in the response to climate change. Farm and household factors influence FO and FS's adaptation strategies. Further, the authors hypothesize that FO and FS react differently when it comes to developing the farm and financial strategies to respond to a perceived climatic change. Since FO makes much of the decision on rice farming in the Vietnam's MRD, the authors expect FO to take a greater interest in responding to climatic changes by developing farming strategies. In contrast, FS would be better suited to responding to climatic changes by developing household/financial strategies.

Our study is based on a methodology that has been mostly used in the agricultural technology adoption and climate change adaptation field. Adoption models are based on farmers' utility or profit-maximizing behaviors (Pryanishnikov and Zigova, 2003). The assumption in this model is that farmers adopt a new technology only when the perceived utility or profit from using this new technology is greater than that obtained using the traditional or the old method. As utility is not directly observed, the actions of economic agents are seen through the choices they make. Therefore, probit and logit models are commonly used in the literature. Maddison (2006) argued that adaptation to climate change be a two-step process that involves perceiving that climate is changing, and then, responding to the changes through adaptation – farm and financial. In our case, FO and FS observe the severity of climate change (stress) – a binary response. However, FO or FS's decision process goes one step further – choosing farm and household financial strategies? Further, the first step is endogenous in the second phase; the empirical framework is presented below.

3. Empirical framework

The decision-making behavior of individuals choosing farm and household financial strategies can be analyzed using a two-stage framework. The first stage is the perception of climate change (severity). The second stage involves the number of farm and household financial strategies that FO and FS choose to reduce the effects of climate change.

The binary choice models such as the logit or probit formulation can be used to model FO and FS's perception of climate change. The second stage would then estimate the number of farms and household financial strategies that FO and FS use to cope with the climatic stress. A two-part model, or the hurdle count model, has served as a methodological cornerstone of empirical analysis in patient and health economics literature (Hausman *et al.*, 1984; Cameron

and Trivedi, 1986; Cincera, 1997; McCall *et al.*, 1991). The number of farm and household financial adaptation strategies can be represented as follows:

$$ADS_i^s = f(y, d, q, PCC) \tag{1}$$

where ADS_i^s is the adaptation strategy, s = FAS and HFAS; I = FO, FS; and y, d and q are the vectors of the farm, individual and regional characteristics, respectively. SCS is an individual's perception of the severity of climate change (stress). The general formulation of a hurdle count model assumes that $f_1(0)$ is the probability of a zero outcome and $f_2(k)$, k = 1,2,3... is the probability function for positive integers. The probability function of the hurdle-at-zero model is given as follows:

$$\begin{aligned} P(Y=0) &= f_1(0) \\ P(Y=k) &= \left(1 - f_1(0)\right) \frac{f_2(k)}{1 - f_2(0)},\ k = 1, 2, 3...., \end{aligned} \tag{2}$$

where $f_2(k)/(1 - f_2(0))$ corresponds to the truncation of $f_2(k)$ at zero, as most of the count distributions have support for non-negative integers. In this study, the authors use the univariate probit model to assess the probability of the binary outcome (perceived SCS) and a negative binomial for the number of FAS and HIFAS used by FO and FS. The probability function for the negative binomial distribution[9] is as follows:

$$\begin{gathered} P(Y{=}K){=}\frac{\Gamma(1/\alpha + k)(\alpha\lambda)^k(1 + \alpha\lambda)^{-(1/\alpha+k)}}{\Gamma(1/\alpha)\Gamma(k+1)k!} \\ \alpha \in R^+,\ \lambda \in R^+,\ k = 0, 1, 2, ..., \end{gathered} \tag{3}$$

Cameron and Trivedi (2010) noted that the distributions are conditional on the explanatory variables; a common assumption in the context of the count data regression model is to make the parameter λ a function of the explanatory variables. Greene (2012) noted that the common formulation of λ is as follows:

$$\ln(\lambda) = \mathbf{X}\boldsymbol{\beta} \tag{4}$$

where $\mathbf{X}$ is the vector of explanatory variables and $\boldsymbol{\beta}$ is the vector of parameters. Note that the log-likelihood function of the probit-negative binomial model is separable; as a result, estimation can be done by maximizing the probit model log likelihood using all observations and then, the log likelihood for the truncated negative binomial using the subset of observations for which the counts are possible (Winkelmann and Zimmermann, 1995; Cameron and Trivedi, 2010). The assumption that the number of FAS and HFAS follows the negative binomial distribution, if the mean of interest is the mean FAS and HFAS used by FO and FS who perceive climatic change and potential changes, then this mean is expressed as follows: $E(y_i|\lambda_i) = \lambda_i$. Finally, there is a potential endogeneity problem with the SCS variable (individual's perception of climate change) in equation (1). The authors conducted a large sample test of endogeneity using the second-stage results and rejected the null hypothesis of no correlation between the endogenous variable (SCS). Thus, a two-stage approach is appropriate. To account for this, the authors first estimated SCS in equation (1). The authors estimated a probit function including the factors explaining SCS by farm

operators and spouses independently. Thereafter, the predicted values of the perception of the severity of climatic stress were added as an independent variable for explaining adaptation strategies undertaken by farm operators and spouses.

4. Data

The data for this study were collected by the International Rice Research Institute (IRRI) in collaboration with the Institute of Policy and Strategy for Agriculture and Rural Development (IPSARD) as part of the Policy Information and Response Platform on Climate Change and Rice in ASEAN and its Member Countries (PIRRCA) Project. In all, 214 households were surveyed with the husband and wife being interviewed separately on climate change perceptions and adaptation strategies. Further, seven districts in three provinces of the Mekong River Delta were selected as part of this survey: Giang Province with 90 households, Bac Lieu Province with 64 households and Tra Vinh Province with 60 households. The survey areas for this study were selected on the basis of prior knowledge on climate change issues facing these locations. Districts, communes and villages were all selected following the same criterion. From a list of farmers with at least 10 years of farming experience at the commune level, the authors selected the households using a stratified random sampling procedure with the same number of respondents from each village. The survey was conducted in the three provinces from December 2014 to January 2015 under the supervision of IPSARD.

Farmer's perception of climate change relates more to the increased variability and uncertainty of specific weather parameters than to long-term climate change (Mertz *et al.*, 2009). Some of these perceptions include the late onset of rains, shorter wet monsoon strong winds with excessive rains, more intense summer heat and unpredictability in the patterns of the seasons. However, in this study of Vietnam's Mekong Delta, the authors queried farmers and their spouses, separately, on the severity of climate change (stress) over time[10]. In particular, they were queried if the climatic stresses have changed over time. In the probit model for FO and FS, SCS = 1, if a change in the severity of climatic stress was observed; 0, otherwise. Once they observed the change in the SCS, FO and FS were queried on the farming and financial strategies that they pursued to manage the risk. In the second step, the dependent variable was the number of farms and financial strategies that FO and FS undertook as a response to climate change. The survey had eight farm-related strategies and 17 household finance-related strategies (see footnotes 7 and 8).

Table I presents descriptive statistics on household and farm characteristics for FO and FS. The average age in the study was a bit under 50 years, which showed that these people were active in farming. In most of the households, FO was older than FS by about four years. A similar observation was noted on the number of years of formal education and the number of years of farming experience. In all the households, farmers and spouses had more than five years of schooling and more than 20 years of farming experience on average. The households considered in our study had roughly five members, and they farmed about 2 hectares of land, a majority of which was owned by them and used mostly for paddy crops. The bottom of Table I shows that there was a significant difference (mean) between farmers and spouses in terms of age, education and farming experience. The farm household income was about 143 million Vietnamese dong[11] (VND) and was primarily derived from rice farming; farming was the main occupation of the FO in our study.

5. Results and discussion

Table II presents the parameter estimates of factors explaining the perception of SCS by farm operators and spouses in Mekong Delta of Vietnam. The authors found that the location of the farm had a significant impact. A plausible explanation is that this variable

Variable	Observation	Mean	SD	Minimum	Maximum
Age of household head (years)	214	48.92	11.55	28	79
Age of spouse (years)	214	45.10	11.34	22	75
Education household head (years)	214	6.62	3.12	0	12
Education of spouse (years)	214	5.25	3.02	0	12
Household head's farming experience (years)	214	28.28	11.59	5	60
Spouse's farming experience (years)	214	24.28	11.25	2	55
Total household size (#)	214	4.79	1.39	2	10
Total farm size (ha)	214	2.02	1.78	0.1	14.3
Farm income (million VND)	214	143.08	193.36	0	1760

	Farm operator	Spouse	Mean difference *t-test*
Age (years)	48.92	45.10	3.82***
Education (years)	6.62	5.25	1.37***
Farming experience (years)	28.28	24.28	4.00***

Sources: Data collected by IRRI, 2014; triple asterisks (***) indicate significance at the 1 per cent level

Table I.
Variable definition and descriptive statistics, Vietnam's Mekong Delta, 2015

	Change in severity of climatic stress (SCS)			
	Estimated coefficients		Marginal effects	
Variable	Farm operator	Spouse	Farm operator	Spouse
Constant	–0.759 (1.408)	–0.568 (1.380)	–1.073 (1.991)	–0.804 (1.952)
Age	–0.0003 (0.010)	–0.005 (0.010)	–0.001 (0.013)	–0.007 (0.015)
Education	–0.014 (0.036)	0.006 (0.041)	–0.019 (0.051)	0.009 (0.058)
Household size	0.103 (0.084)	0.114 (0.086)	0.146 (0.119)	0.162 (0.121)
Farm size	0.154 (0.166)	0.137 (0.162)	0.218 (0.234)	0.193 (0.230)
Farm income	–0.087 (0.118)	–0.082 (0.109)	–0.124 (0.166)	–0.115 (0.154)
Bac Lieu	0.413* (0.261)	0.397* (0.259)	0.583* (0.369)	0.562* (0.366)
Vinh Tranh[a]	0.474* (0.272)	0.475* (0.267)	0.671* (0.385)	0.671* (0.378)
# of observations	212	212	212	212
LR chi-square(7)	7.7	7.93		
Prob > chi-square	0.35	0.33		
Wald chi-square(7)			6.52	7.01
Prob > chi-square			0.48	0.42
Log likelihood	–92.73	–92.62	–92.73	–92.62
Pseudo-R^2	0.04	0.04	0.04	0.04
Predicted probability[b]	0.83 [0.06]	0.83 [0.07]		

Notes: [a]Giang province is used as a reference in the negative binomial regression; single asterisk (*) indicate significance at the 10 per cent level; [b]values represent the mean of the predicted probability of the perception of the severity of climate change stress; values in brackets are the standard deviation

Table II.
Parameter estimates of factors explaining the perception of severity of climatic stress by farm operators and spouses in Vietnam's Mekong Delta

may be capturing the weather effects and/or other location-specific variables that may explain the perception of climatic stress. As our focus was on investigating the effect of SCS on the farm and household finances adaptation strategies, the estimates of SCS for both FO and FS are presented in Table III. In particular, Table III presents parameter estimates and marginal effects of factors explaining FAS used by FO and FS. Indeed, the authors found

Variable	Farming adaptation strategies (FAS) Farm operator	Marginal effects	Spouse	Marginal effects
Constant	–7.007*** (2.575)		–0.626 (2.912)	
Predicted probability of SCS	0.12*** (4.86)	0.11*** (4.69)	0.02 (5.23)	0.01 (4.16)
Age	0.004 (0.010)	0.004 (0.010)	–0.001 (0.014)	–0.006 (0.011)
Education	0.067*** (0.028)	0.064*** (0.027)	0.003 (0.031)	0.003 (0.025)
Farming experience	0.025 (0.030)	0.024 (0.029)	–0.043 (0.031)	–0.034 (0.024)
Farming experience squared	–0.0003 (0.0005)	–0.0003 (0.0004)	0.0009* (0.0005)	0.0007* (0.0004)
Household size	–0.286*** (0.116)	–0.273*** (0.113)	–0.085 (0.145)	–0.068 (0.116)
Farm size	–0.224 (0.153)	–0.214 (0.146)	–0.023 (0.153)	–0.021 (0.122)
Farm income	0.062 (0.045)	0.059 (0.042)	0.015 (0.050)	0.012 (0.040)
Bac Lieu	–1.027** (0.516)	–0.979** (0.496)	–0.130 (0.539)	–0.104 (0.428)
Vinh Tranh[a]	–0.883 (0.584)	–0.841 (0.560)	–0.044 (0.644)	–0.035 (0.512)
# of observations	214		214	
LR chi-squared(10)	21.24		5.67	
Prob > chi-squared	0.019		0.84	
Log likelihood	–242.6		–232.75	
Pseudo R^2	0.04		0.02	

Notes: [a]Giang province is used as a reference in the negative binomial regression; single, double and triple asterisks (*, ** and ***) indicate significance at the 10, 5 and 1 per cent level, respectively; predicted probabilities of SCS is in percentage

Table III. Parameter estimates of factors affecting the number of farm adaptation strategies used: negative binomial count model

that the predicted probability of SCS had a positive and significant effect on FAS, but only in the case of FO. The findings suggested that the number of FAS increased with an increase in the probability associated with SCS. For example, a 10 per cent increase in the likelihood of perceived SCS by PO increased the number of FAS by about 1. In Vietnam and many developing countries, when it comes to farming, FO is the major decision maker[12] (Dang *et al.*, 2014). Educational attainment of the FO is another important factor explaining the number of FAS. In Vietnam, our data revealed that FO had higher education than their counterparts (Chi *et al.*, 2013). The coefficient on education was positive suggesting that more skilled FO tended to seek additional strategies to stabilize and increase farm income, although the marginal effect was small. Our findings are similar to those of Mishra *et al.* (2004) who found that small farms in the USA with skilled FO were likely to have a greater number of agricultural enterprises. Our findings are consistent with those of Deressa *et al.* (2011) who found that educated farmers in the Nile basin of Ethiopia were more likely to adapt to climate change.

The coefficient on household size was negative and statistically significant at the 1 per cent level of significance. Results suggest that a 10 per cent increase in household size (i.e. 10 per cent additional household members) decreased the number of FAS by about 3. Our findings are consistent with those of Mishra *et al.* (2002) who argued that large farm families have higher consumption expenditures and to meet these expenses, household members are likely to have multiple job holdings to increase the total household income. These multiple jobs may help in increasing or stabilizing the household income. More experienced FS tended to consider more FAS when they perceived a change in SCS. On this finding, the authors posit that FO-dominated farming strategies, but FS had a chance to consider farming strategies once their experience in rice farming made a difference. Finally, Table III reveals that as compared to farms located in the An Giang province, farms located in the Bac Lieu province had a significantly lower number of FAS (about one less FAS). Note that the

Hau river runs through the Ag Giang province, whereas the Bac Lieu province's eastern shore is exposed to the South China Sea. Farms located in the Bac Lieu and Vinh Tranh provinces face a greater salinity issue (Thuy and Anh, 2015).

Table IV reports the parameter estimates and marginal effects for factors affecting the number of HFAS with SCS for both FO and FS. The findings suggested that the number of HFAS increased with an increase in the probability associated with the SCS for both FO and FS. For example, a 10 per cent increase in the perceived SCS by FO increased the number of HFAS by about 1.5. However, in the case of FS, a 10 per cent increase in the perceived SCS increased the number of HFAS by about 2, slightly higher than in the case of their husbands. This finding is consistent with the fact that a majority of women in developing countries make household decisions (such as food expenditures, savings, selling of livestock and borrowing money; see Quisumbing, 1994a; Kelkar *et al.*, 2008; Chi *et al.*, 2013). The fact that the predicted probability of SCS is significant for both husband and wife with respect to HFAS could simply be that household decisions are evaluated and discussed jointly. The authors also found that with perceived SCS, skilled FO were likely to increase the number of HFAS.

Several factors, such as household size, farm size and farm income, had a significant effect on the number for HFAS for both FO and FS. For example, an increase in farm size and household size decreased the number of HFAS by both FO and FS. Results presented in Table III indicate that a 10 per cent increase in household size will make FO and FS reduce the number of HFAS by 4 and 6, respectively. A plausible explanation is that increases in household size may induce members to work outside the farm in non-agricultural income-generating activities. Additional family labor that is not being used on the farm can work in the non-agricultural jobs to increase or stabilize the household income. Additionally, the agricultural household may diversify into non-agricultural income-generating activities for a variety of reasons.

Diversification can serve as a response to market failures, such as in credit markets, providing cash and relaxing liquidity or credit constraints in agricultural activities. The

Table IV.
Results of the parameter estimates of factors affecting the number of household adaptation strategies (HFAS) used: negative binomial count model

Variable	Household financial adaptation strategies (HFAS)			
	Farm operator	Marginal effects	Spouse	Marginal effects
Constant	–7.053*** (2.784)		–5.996*** (2.440)	
Predicted probability of SCS	0.13*** (5.32)	0.15*** (6.17)	0.13*** (4.54)	0.20*** (6.69)
Age	–0.001 (0.011)	–0.001 (0.012)	0.019* (0.011)	0.027* (0.015)
Education	0.068** (0.030)	0.077** (0.034)	–0.015 (0.026)	–0.022 (0.036)
Farming experience	0.026 (0.031)	0.030 (0.035)	0.035 (0.027)	0.050 (0.039)
Farming experience squared	–0.0003 (0.0004)	–0.0003 (0.0005)	–0.0001 (0.0005)	–0.0008 (0.0007)
Household size	–0.412*** (0.130)	–0.466*** (0.153)	–0.428*** (0.128)	–0.618*** (0.189)
Farm size	–0.274* (0.163)	–0.309* (0.187)	–0.396*** (0.132)	–0.572*** (0.194)
Farm income	0.084* (0.049)	0.094* (0.056)	0.091** (0.047)	0.131** (0.069)
Bac Lieu	–0.892* (0.562)	–1.008* (0.642)	–1.354*** (0.463)	–1.955*** (0.681)
Vinh Tranh[a]	–1.320** (0.648)	–1.493** (0.745)	–1.449*** (0.555)	–2.092*** (0.813)
# of observations	214		214	
LR chi-squared(10)	22.22		20.30	
Prob > chi-squared	0.014		0.026	
Log likelihood	–299.66		–332.60	
Pseudo R^2	0.03		0.03	

Notes: [a]Giang province is used as a reference in the negative binomial regression; single, double and triple asterisks (*, ** and ***) indicate significance at the 10, 5 and 1 per cent level, respectively; predicted probabilities of SCS are in percentage

coefficient on farm size was negative and statistically significant in both cases (FO and FS). Mishra *et al.* (2004) found that large farms in the USA tend to specialize in agricultural production – economies of scale – and tend to have higher income and wealth. In these cases, farm families tend not to diversify their household portfolio. In contrast, results in Table III show that farm income has a positive effect on HFAS. This is consistent with the fact that higher-income households tend to diversify their assets into liquid and non-liquid assets. Therefore, in the presence of SCS, wealthy households are more likely to increase the number of HFAS in the cases of both FO and FS (as a household entity). Finally, Table III reveals that as compared to farms located in the An Giang province, farms located in the Bac Lieu and Vinh Tranh provinces province have a significantly lower number of HFAS (about 1 and 2 less HFAS by FO and FS, respectively). Because of data limitation, this study was not able to explain in detail why intrahousehold differences exist in the number of farm adaptation strategies and household adaptation strategies between FO (husband) and FS. This is left for future studies. The Women's Empowerment in Agriculture Index (WEAI) developed by the International Food Policy Institute (IFPRI) may be used to better understand the household decision-making process.

6. Conclusion and policy implications

Climate change is a major environmental challenge for Vietnam. Climate change also leads to a strong fluctuation in rainfall and an increase in extreme weather and climate conditions, such as floods and droughts. With global climate change, the impact and frequency of extreme weather events are expected to intensify. Increased extent and duration of flooding, changes in wet and dry season precipitation, inundation from sea-level rise and changes in salinity intrusion could be significant threats to the region's agricultural and fisheries productivity. Therefore, it is necessary to tease out the key factors affecting the perception of climatic stress in a specific region and by both FO and FS in farming households. Additionally, how this perception of climatic stress shapes their adaptation strategies with respect to both agriculture and the household. In this study, the authors investigated the factors affecting the perception of the severity of climate change by FO and FS, separately. Secondly, what HFAS do farmers and spouses adopt to reduce the impact of perceived SCS? Our findings revealed that the perception of SCS had a positive and meaningful impact on adaptation strategies for both farming enterprises and household finances.

In the year 2015, Vietnam submitted its Intended Nationally determined Contributions target to the United Nation Framework Convention on Climate Change (UNFCCC) that includes the adaptation strategies for managing climatic stress. Decision makers are increasingly in need of information on adaptation strategies for rice production. For effective policy design, detailed knowledge of farming strategies and household financial conditions is essential. This study reveals that substantial benefits could be achieved from developing climate-smart rice varieties that are tolerant to floods and salinity. Investment in climate-smart agriculture can better help farmers to cope with the climatic changes affecting not only Vietnam but also smallholder farms in many South and Southeast Asian countries. Our study provides evidence that gender is an important issue in adaptation strategies depending on how they perceive changes in SCS. Moreover, our study underscores the notion that climate policies at the local level should be gender-sensitive. Given that FS tend to respond to their perceived SCS by considering more household and financial strategies, local policies can be seen as a reinforcement to successfully manage these strategies. For instance, local policies aimed at promoting income-generating activities for households could be beneficial for increasing their resilience to climate change.

Notes

1. Using the US$1.90 2011 PPP line.
2. Rising sea levels and other effects of climate change on the coastal resources sector are projected for Southeast Asia (USAID, 2010), where a rise of 1 m in sea level could put 7.8 million people at risk, including 11 per cent of the population of Vietnam (Francisco 2008).
3. For example, women in Cameroon provide more than 75 per cent of the agricultural labor but own only 10 per cent of the land (Mason and Carlsson, 2004). Similar differences were found in Kenya and Zambia (Quisumbing, 1994b).
4. Smith and Haddad (2000) and Adger *et al.* (2007) argued that adaptations, or particular adjustments in a system to better cope with external stress, are manifestations of adaptive capacity. Additionally, there are many forms of adaptations including anticipatory or reactive, autonomous or planned, local or widespread, and technological, behavioral, financial, institutional and/or informational.
5. Vedwan and Rhoades (2001) noted that in developing countries, the common approach to studying the perception of farmers to climate change is based on comparing farm survey or farm group discussions with data records from meteorological stations.
6. Farmers and spouses were queried about climatic stresses that they observed in their area, including flood, storms, drought, salinity, heat and the rise in sea level. Multiple responses could be recorded. If the respondent reported climatic stress, then the surveyor queried the respondent if the climatic stress changed over time. If the respondent answered in affirmative, then he/she was queried on the severity of climatic stress over time. In particular, the respondents were asked whether the severity of the climatic stress has worsened over time.
7. FO and FS were queried on "what changes in your farming activities did you do during climatic stress". The responses were change cropping pattern, change rice variety, shift from crops to livestock, grow more kinds of crops, grow dry fodder crops, crop relocation, leave fallow, no change and others.
8. FO and FS were queried on "what coping strategies do you do during climatic stress". The responses were nothing, reduced consumption, sold land, sold livestock, sold other assets, got assistance from friends and relatives, got assistance from government, got assistance from NGO, borrowed money from bank, borrowed from others, got insurance payments, postponed payments of loans, worked more, took children out of school, used savings and others.
9. Cameron and Trivedi (2010) noted that the choice of the distribution in the hurdle specifications is important and the use of a flexible distribution is preferred.
10. Farmers and spouses were queried about climatic stresses that they observed in their areas, including flood, storms, drought, salinity, heat and the rise in sea level. Multiple responses could be recorded. If the respondent reported climatic stress, then the surveyor queried the respondent if the climatic stress changed over time. If the respondent answered in the affirmative, then he/she was queried on the severity of climatic stress over time.
11. US$1 = VND22,303 or VND1 = US$0.0000448.
12. Decisions regarding the sale and purchase of land, technology adoption, water usage and day-to-day operations of the farm.

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