

An economic analysis of how the rural poor in Vietnam cope with income shocks

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ABSTRACT

Poor rural households who largely depend on agriculture for their livelihood are highly vulnerable to natural disasters and health shocks which reduce their income, damage productive assets and their capacity to work. Households have developed a wide range of strategies to cope with the income losses from shocks so that they can smooth consumption, whilst trying to maintain their ability to earn income in the future. Lack of evidence, in the literature, for consumption smoothing by poor households has been attributed to a lack of capacity for self-insurance through asset depletion and limited access to credit markets and formal insurance. There is evidence for communal risk-sharing, through private transfers and credits, when a household suffers an idiosyncratic shock, such as a health shock, but these risk-sharing mechanisms fail when a shock is covariate and affects all households in a commune, for instance a flood or typhoon.

Policy responses in Vietnam to covariate shocks include short-term relief, agricultural insurance schemes and income support payments. For idiosyncratic health shocks, the health insurance scheme reduces the cost of medical treatment and in extreme cases would trigger income support. The literature finds evidence of policy inefficiency in that relief funding for major covariate shocks is often delayed and in some cases the capacity of disaster affected communes to provide public transfers may be reduced by the shock. Agricultural insurance markets in Vietnam have failed due to a lack of demand. In the case of an animal disease shock, compensation is often excessive. The evidence suggests the need to allow for alternative hypotheses in testing household behaviours in response to income shocks and the effect of shocks on households' risk preferences. We use a large balanced panel data survey conducted biannually for four waves 2006 to 2012 for the tests.

As a preliminary analysis to testing behaviours in response to income shocks, a comparison of data on self-reported shocks and independently reported shocks is completed. The evidence suggests that the perception of a shock is endogenous to the household. Households affected by the same flood will self-report the shocks differently dependent upon their engagement in agriculture. Relatively low income households that have diversified out of agriculture into low income waged employment are less likely to report shocks. On the basis of this analysis independently measured shocks are used to measure covariate shocks.

The alternative hypotheses of consumption smoothing and asset smoothing are tested in analysing household response to shocks. The shocks are: health shocks (idiosyncratic shock), floods, animal diseases and crop diseases (covariate shocks). We find evidence supporting consumption smoothing against idiosyncratic shocks, and a lack of consumption smoothing against covariate shocks. The Complete Market Hypothesis (CMH) is therefore supported. The Permanent Income Hypothesis (PIH) is therefore rejected because the effects of income shocks are not found to be transitory. Floods are the most severe covariate shocks as they reduce both income and risk-sharing networks, and opportunities for casual non-farm works. We find evidence in support of asset smoothing behaviours. Households accumulate more productive assets when covariate shocks happen and the changes in assets balances are not affected by all income shocks. These behaviours are most evident among households who spend most of their labour days on agriculture. In the case of crop diseases, households use credit to support agricultural production and reduce consumption. There is a bifurcation in consumption smoothing behaviours for different levels of assets and education: Households with significant productive assets smooth assets and reduce consumption when crop disease occurs and smooth consumption against floods;

households with negligible productive assets smooth consumption against crop disease, but fail to smooth consumption against floods because of their high dependence on the labour market.

The survey in 2010 and 2012 asked respondents a set of hypothetical lottery choices to measure risk aversion and loss aversion. This data was used to test the stability and nature of risk preferences using the alternative models of expected utility and cumulative prospect theory. The results indicate that risk preferences are unstable between the two years. Furthermore, income shocks change the risk preference of rural households. Lower incomes make farmers more risk averse. However, there is a possibility of farmers becoming risk-seeking after a shock is experienced. We find evidence of reference-dependent risk preferences, with the presence of loss aversion and risk seeking behaviours in the loss domain after controlling for the income effect of shocks. There is a switch in risk behaviours when agricultural households approach the poverty line. These households are willing to take more risks when their income decreases. This is in contrast with the very high and very low income groups, who consistently take less risk as their incomes decreases.

The findings have important implications for policies targeted at poor rural households. The motivation to smooth productive assets and take risk of the households near the poverty line necessitates a re-consideration of current focus on income support and formal insurance market. Social network is crucial to the risk-coping capacity of rural households. In addition it is necessary to reinforce non-farm diversification with a more developed labour market which is resilient to agricultural shocks. It is notable that for all development policies the labour quality is the key to success.

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ABBREVIATIONS AND ACRONYMS

AgriBank: Agricultural Bank of Vietnam
ARA: Absolute Risk Aversion
ASPS: Agriculture Sector Program Support
AST: Asset Smoothing Theory
BSPS: Business Sector Program Support
CARA: Constant Absolute Risk Aversion
CFSR: Climate Forecast System Reanalysis
CIEM: Central Institute for Economic Management of Vietnam
CMH: Complete Market Hypothesis
CPT: Cumulative Prospect Theory
CRRA: Constant Relative Risk Aversion
DANIDA: Danish International Development Agency
DARA: Decreasing Absolute Risk Aversion
DM: Decision Maker
DRRA: Decreasing Relative Risk Aversion
EMDAT: The International Disaster Database
EP: Expo-Power
EUT: Expected Utility Theory
EVT: Expected Value Theory
FTP: Flexible Three Parameter Form
GSO: General Statistical Office of Vietnam
IARA: Increasing Absolute Risk Aversion
IMF: International Monetary Fund
IRRA: Increasing Relative Risk Aversion
MARD: Ministry of Agriculture and Rural Development
OIE: World Organization for Animal Health
OLS: Ordered Lottery Selection
PIH: Permanent Income Hypothesis
PNV: Predictive Negative Value
PPT: Predictive Positive Value
PRA: Power Risk Aversion
PT: Prospect Theory
RDU: Rank-Dependent Utility
RRA: Relative Risk Aversion
UNDP: United Nations Development Programme
UNISYS: Global Information Technology Company
VARHS: Vietnam Access to Resources Household Survey
VBSP: Vietnam Bank for Social Policies
VHLSS: Vietnam Household Living Standard Survey
WTP: Willingness To Pay (for a lottery)

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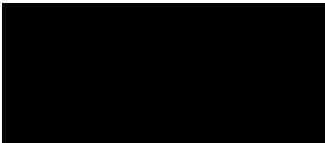
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Date:		
I, Benedict White certify that the student statements regarding their contribution to each of the works listed above are correct		
Coordinating supervisor signature:		27/02/2018
Date:		

CHAPTER 1

Thesis Introduction

1.1 Research Background

Reducing poverty is the top Millennium Development Goal (UNDP, 2017a) and Sustainable Development Goal (UNDP, 2017b). The existence and cause of extreme poverty and poverty traps amongst rural households is a key issue in development economics. Income shocks, due to a range of different sources, are an important determinant of poverty as they can set households backwards and prevent them from escaping poverty (Carter & Barrett, 2006; Dercon, 1998; Krishna, 2010; McPeak & Barrett, 2001). Rural households in developing countries are characterised by low incomes and high vulnerability to income shocks, especially shocks due to natural disasters (Fafchamps, Udry, & Czukas, 1998; Gloede et al., 2015; Kazianga & Udry, 2006; Lohmann & Lechtenfeld, 2015; Pandey et al., 2007). Households individually and collectively have the capacity for some level of self-support and communal support when disasters occur. These coping mechanisms in the face of extreme shocks need to be supplemented by targeted welfare support to prevent households and communities falling below the poverty line and potentially into a poverty trap. The subject matter of this thesis is how households and communities respond to different forms of income shocks and the motivation for such behaviours.

The original theories to explain household responses to income shocks (Jappelli & Pistaferri, 2010; Mayer, 1972) assume that consumption smoothing is the household's aim. Risk-coping strategies are the *ex post* responses of households to smooth consumption after income shocks occur. More recent theoretical models for developing countries (Carter & Lybbert, 2012; McPeak, 2004) hypothesise that productive assets, such as breeding livestock, are smoothed and consumption is allowed to vary. Central to the study of risk-coping strategies for poor rural households therefore is an understanding of their

motivations. Failure to account for household motivations can lead to wasteful public intervention. For example, in response to the widespread production shocks, some governments subsidise agricultural development programs. Many of these subsidised programs have low levels of uptake (De Bock & Gelade, 2012). They also do not help households manage future income risks by diversification.

If households are entirely motivated by consumption smoothing, when they suffer an income shock they will reduce investment and thus productivity. In contrast, if they are motivated by asset smoothing, investment in assets - especially those damaged by natural disasters - increases their productivity and helps them move away from the poverty trap. By analysing smoothing behaviours towards consumption and assets of poor rural households in Vietnam, we provide a case study of the strategies adopted by a sample of poor households in a rapidly growing liberalising economy.

1.2 Context and Problem Statement

Vietnam is developing and industrialising rapidly. Data from the World Bank shows that even though the per capita GDP is still relatively low, Vietnam has deregulated many markets, including financial and labour markets. In particular, the data shows a strong increase in savings and credits. Savings coverage increased rapidly among the poorest while credit exceeded total GDP in 2009. While agricultural land area shows an upwards trend with more investments in tractors and other productive assets, its contribution to GDP has decreased substantially. This is partly explained by a strong decrease in employment in agriculture, from 70% in 1996 to only 47% in 2012, and an increase in the manufacturing sector from 11% to 27% and service sector from 19% to 32%. It is also noted that together with the increase in liberalised credit and labour markets, the indicator on adequacy of the social safety net has steadily decreased from 14% in 2006 to only 2.5% in 2012. Education

in Vietnam is relatively well developed, with high levels of school enrolment and literacy (WorldBank, 2016).

Rural areas in Vietnam are characterised by a high dependence on agriculture with more than 70% of the work force employed in agriculture (GSO, 2011). A disproportionately large number of rural households are in the lowest income and consumption quantiles (GSO, 2008, 2010, 2012). In addition, agricultural production is highly susceptible to natural disasters. The Vietnamese government has a subsidy program for agricultural production loss from natural disasters and animal diseases, which only partially compensates farmers for their losses (Wainwright & Newman, 2011). In common with other developing countries, the agricultural insurance market has not developed despite a high level of subsidy to farmers to purchase crop and other forms of agricultural insurance (MOF, 2013, p. 288).

In the face of these challenges, rural areas of Vietnam have witnessed a rapid income increase in the last decade. The poverty headcount in rural areas shows a decrease from 27% in 2010 to 22% in 2012 and 18.6% in 2014 (World Bank, 2016). This study is concerned with poor households that have benefitted from the increase in average income. We study a sample of representative poor rural households from a sample of rural regions. The focus of the study is on their smoothing behaviours as an *ex post* coping mechanism in response to income shocks and the determinants of such mechanisms. Findings from this study will contribute to understanding the economic development process in rural areas where some households appear to be by-passed by the overall economic development.

1.3 Research Hypotheses

The effect of shocks on households' behaviours is illustrated in Figure 1.1. The shocks in the diagram are exogenous, observable and distinguished between covariate and

idiosyncratic shocks. Covariate shocks affect many households and are correlated within a community. Idiosyncratic shocks are specific to each household and uncorrelated within a community. As can be seen, there are two approaches to evaluating the effects of shocks. The direct approach uses shock as the single determinant of all household characteristics: labour income, risk preference, risk-sharing strategies and consumption and asset accumulation behaviours. The indirect approach uses the income effect of shocks that triggers risk-sharing mechanisms, consumption and asset accumulation behaviours, as well as risk preferences. We apply two approaches flexibly in the thesis. The direct approach is indicated by the solid line. The indirect approach is indicated by the dashed line.

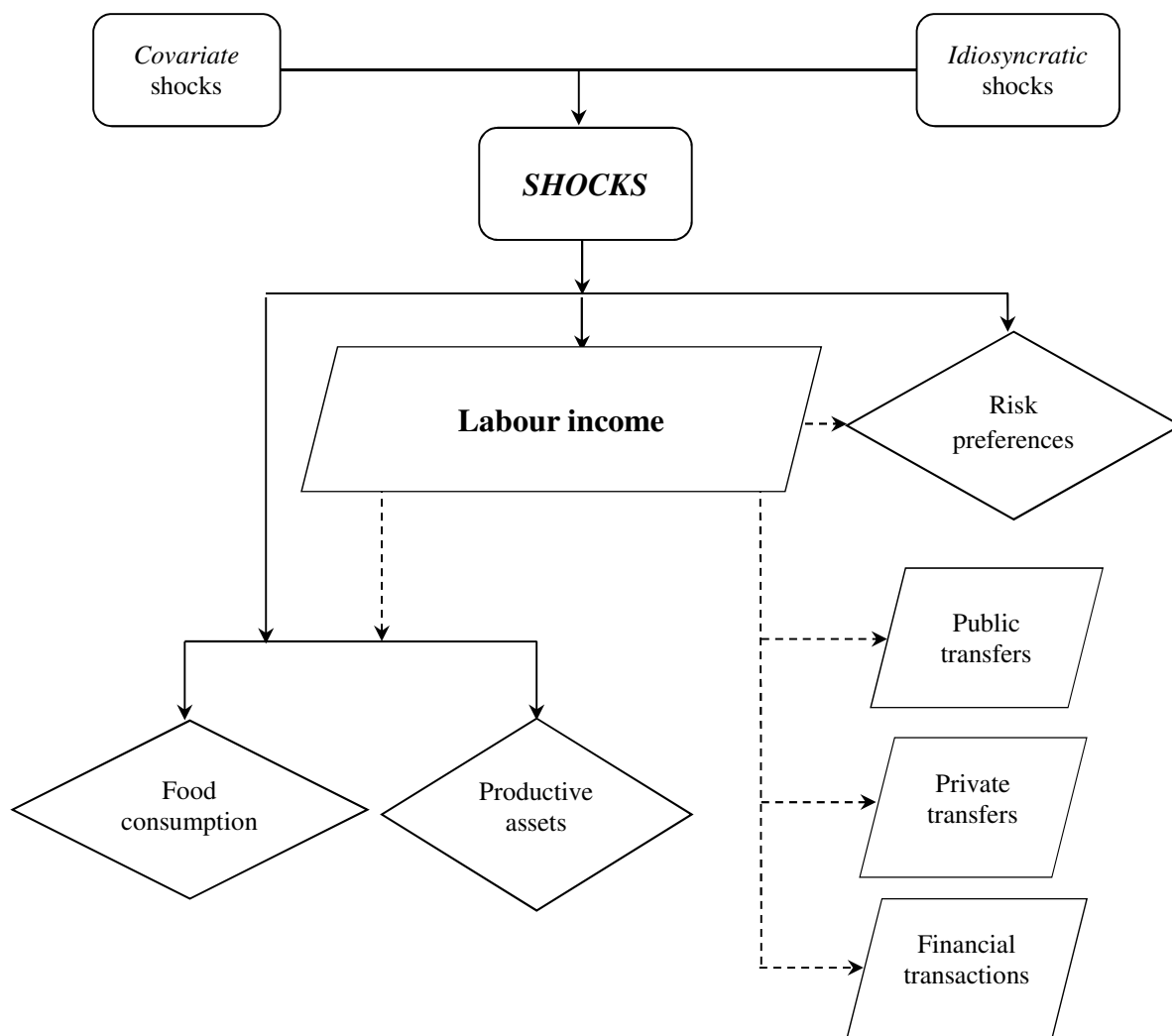


Figure. 1.1: Conceptual framework of shock effects

The direct approach has the advantage of distinguishing between the gross effect and the net effect of shocks. In particular the gross effect refers to the income losses due to shocks. The net effect refers to the changes in consumption after applying different risk-coping measures to cover for the income losses. The disadvantage of the direct approach is its failure to quantify the extent to which the risk-coping measures can cover the income losses, which is feasible under the indirect approach. Using the direct approach, we evaluate the effect of shocks on labour income of rural households. We also evaluate the effect of shocks on consumption expenditure of food and the accumulation of productive assets. Using the indirect approach, we evaluate the income effect due to shocks on the funds generated by transfers and financial transactions to smooth food consumption *or* finance asset accumulation. The reason for the analysis on the indirect effect of shocks on risk-sharing mechanisms is that we are interested in the extent to which risk-sharing mechanisms cover the short-fall in income due to shocks rather than the trigger of risk-sharing mechanisms *per se*. Similarly, in analysing risk preferences, we use both direct and indirect effects of shocks through income. We are interested in the income effect of shocks on risk attitudes as well as the occurrence of shocks on the stability of risk preferences revealed by the affected households. In particular, we aim to test the following three main hypotheses:

Hypothesis 1: Covariate shocks have a larger damaging impact on poor rural households than idiosyncratic shocks. The risk-sharing networks are triggered and effective when idiosyncratic shocks occur. However, such networks are ineffective when covariate shocks happen.

Hypothesis 2: Rural households are strongly motivated to smooth productive assets at the expense of reduced consumption to improve the income generation process after shocks occur. However, with the presence of labour markets, such behaviours may be replaced by the tendency to diversify into non-farm opportunities.

Hypothesis 3: The occurrence of shocks changes the risk preferences of poor rural households.

1.5 Contribution to Research Originality

The thesis provides both theoretical and empirical contributions. First it provides empirical evidence on the effect of observable shocks on income and consumption of poor rural households. Second, it is among a small number of studies that combine tests of consumption and asset smoothing on a large sample size of panel data. It therefore provides explanations for asset smoothing versus consumption smoothing among poor rural households when the theoretical assumptions of a non-market economy are relaxed. The third contribution is the empirical tests on risk behaviours of poor rural households when their incomes are affected by shocks. We are able to distinguish the income effect of shocks and the background effect of shocks on risk preferences. We further link the behaviours of these farmers to the current theoretical frameworks on decision making under uncertainty and propose an alternative framework to study risk behaviours. Throughout the study, we are able to demonstrate two important trends in rural developments of developing countries. First is the importance of social networks in providing risk-sharing strategies that help poor rural households overcome idiosyncratic income shocks, and the importance of social comparison in determining the risk behaviours of these households. Second is the role of non-farm diversification in the risk perceptions of these households and the response to income shocks.

1.6 Thesis Organisation

The thesis is organised into seven chapters. This chapter is dedicated to providing the overview of the thesis structure.

Chapter 2 reviews literature on the consumption and asset smoothing theories used in this thesis. This chapter reviews the development of the Permanent Income Hypothesis proposed by Friedman (1957) and compares this with the subsequent development of Complete Market

Hypothesis (Cochrane, 1991; Mace, 1991). On the background of this comparison, developments of Asset Smoothing Theory are reviewed.

Chapter 3 provides a descriptive analysis of the sample data and its variations across regions and survey periods. This chapter provides a preliminary understanding of the sampled households in terms of income activities, exposure to shocks and the availability of resources. It also provides a regional comparison of the development rates and lays the groundwork for subsequent analyses.

Chapter 4 explains the choice of shock measures. Among the many different approaches, we show that observable shocks can be measured either by using perceived shocks elicited in the survey or by developing a variable from independent data. We show the advantages and disadvantages of each approach and show how the perceived shocks are strongly linked to the non-farm diversification behaviours.

Chapter 5 analyses the smoothing behaviours of poor rural households in the sample and how these behaviours are reconciled with theoretical predictions. This chapter also evaluates the adequacy of current risk-coping strategies and social protection network for poor rural households in Vietnam. We test hypotheses (1) and (2) in this chapter.

Chapter 6 reviews different theories of decision making under uncertainty and empirical evidence on the relation between income shocks and risk preferences.

Chapter 7 provides empirical evidence on changes in risk preferences due to income shocks. We first use different theoretical frameworks to measure risk preferences and then show how unstable these measured risk attitudes are. We then analyse the shortcomings of each approach and propose a reference-dependent framework for analysing risk preferences, which is linked to a comparison of social status.

Chapter 8 provides the overall conclusion of the thesis.

CHAPTER 2

Review of Background Theories

2.1. Introduction

Literature on risk-coping strategy implicitly assumes that households strive to smooth consumption in the face of income shocks. This motivation is the basis for categorising ex-post behaviours of borrowing, depletion of previously accumulated assets, savings and goods storage as a set of risk-coping strategies (Alderman & Paxson, 1992; Morduch, 2004; Pandey et al., 2007). Lack of consumption smoothing therefore has normally been attributed to the inadequacy of risk-coping strategies (Amin, Rai, & Topa, 2003; Pandey et al., 2007; Rosenzweig & Wolpin, 1993; Townsend, 1995). However, ex-post behaviours of households in the face of income shocks can be driven by other motivations. A recent development in studies on smoothing behaviours has challenged the long established assumption of consumption smoothing motivation. In contrast, household behaviours are proposed to be driven by asset smoothing motivation (Zimmerman & Carter, 2003). This development necessitates a study of the assumptions used in building theoretical models of consumption smoothing and the subsequent theoretical model of asset smoothing. In this chapter, we discuss the most predominant theoretical models of smoothing behaviours, which serve as the background theories for making predictions about household behaviours in response to income shocks.

The structure of this chapter is as follows. Section 2.2 discusses two predominant theories which assume that households aim to smooth their consumption against income shocks. In this section we describe the assumptions used and the tests developed for these theories. We further make a comparison between the two theories. Section 2.3 discusses the development of an alternative theory which assumes that households aim to smooth assets against income shocks. We show the key difference between the asset smoothing theory and the consumption smoothing theories before concluding in section 2.4.

2.2. Consumption Smoothing Theories

We distinguish between intertemporal and inter-household consumption smoothing theories. Intertemporal consumption smoothing refers to the situation where households determine consumption based on a time horizon of income generation, rather than current income. Inter-household consumption smoothing is where households allocate consumption according to rules of reciprocity and mutual support within their extended family and the community.

The *Permanent Income Hypothesis* (PIH) as proposed by Friedman (1957) represents intertemporal smoothing theory; *Complete Market Hypothesis* (CMH) (Cochrane, 1991; Mace, 1991) and the termed *Full Insurance Theory* by Townsend (1994) represent inter-household consumption smoothing theory. Other related theories are not discussed because they have similar predictions about smoothing behaviours.¹

PIH and CMH are the dominant theoretical models of the relationship between consumption and income. We review these theories and how they lead to the development of Asset Smoothing Theory.

2.2.1 Permanent Income Hypothesis (PIH)

Milton Friedman's book on *Consumption Function* (1957) develops a new approach to consumption analysis. Mayer (1972, p. 41) summarises the three main propositions:

- (i) Consumption is a function of long-run ("permanent") income
- (ii) Permanent consumption is proportional to permanent income, and
- (iii) The propensity to consume transitory income is zero

¹ Another theory of intertemporal consumption smoothing theory is the Life Cycle Hypothesis proposed by Modigliani and Brumberg (1954). Another representative of inter-household consumption smoothing theory is Relative Income Theory (Duesenberry, 1949). Life Cycle Theory is similar to Permanent Income Hypothesis in that consumption is determined by a life plan of income generation rather than the current income. Duesenberry's Relative Income Theory is similar to Complete Market Hypothesis in that household consumption is affected by their community's consumption: "The strength of any individual's desire to increase his consumption expenditure is a function of the ratio of his expenditure to some weighted average of the expenditures of others with whom he comes into contact" (Duesenberry, 1948, p. 74).

The second proposition, namely the *Proportionality Hypothesis*, implies households save and dis-save transitory income to ensure consumption smoothing against transitory income. Friedman (1957) designed 16 tests on his hypothesis for both time series and cross-section data and found support for PIH. These tests have since been widely critiqued (Mayer, 1972). However, the results from various tests on the proportionality hypothesis are mixed. The main reason for mixed evidence is the flexibility of the hypothesis in providing a “loose definition of permanent income” (Meghir, 2004, p. 296). Friedman (1957, p. 23) stated that permanent income is best defined “...to be whatever seems to correspond to consumer behaviour.” Therefore, permanent income can have a range of empirical definitions.

Of the many possible ways of defining permanent income, we follow Deaton (1992, p. 81) to take the approach where “*permanent income is the annuity value of current financial and human wealth, and in which consumption is set equal to permanent income*”. Consumption c at time t is:

$$E_t c_{t+k} = c_t \quad (2.1)$$

where E_t is the expectation operator based on information at time t . The preference is assumed to be intertemporally separable. The realized consumption plan from t to T satisfies:

$$\sum_{k=0}^{T-t} (1+r)^{-k} c_{t+k} = A_t + \sum_{k=0}^{T-t} (1+r)^{-k} y_{t+k} \quad (2.2)$$

where A_t is financial asset, r is the constant real interest rate that is equal to the rate of time preference, y_t is labour income in period t , and T is the date of death of a consumer who plans to die with no assets.

From (2.1) and (2.2), if T goes to infinity, the permanent income hypothesis then becomes

$$c_t = r/(1+r) A_t + r/(1+r) \sum_{k=0}^{\infty} (1+r)^{-k} E_t y_{t+k} \quad (2.3)$$

When we use the asset evolution equation to substitute for A_t (2.3) becomes

$$c_t = r(A_{t-1} + y_{t-1} - c_{t-1}) + r/(1+r) \sum_{k=0}^{\infty} (1+r)^{-k} E_t y_{t+k} \quad (2.4)$$

When we lag (2.3) by one period, multiply by $(1+r)$ and rearrange (2.3), we have:

$$(1+r)c_{t-1} = rA_{t-1} + ry_{t-1} + r/(1+r) \sum_{k=0}^{\infty} (1+r)^{-k} E_{t-1} y_{t-k} \quad (2.5)$$

Subtract (2.5) from (2.4), we have:

$$\Delta c_t = r/(1+r) \sum_{k=0}^{\infty} (1+r)^{-k} (E_t - E_{t-1}) y_{t+k} \quad (2.6)$$

This equation is the basis of *excess sensitivity test* developed by Flavin (1981). The test is based on the work by Hall (1978) who reformulated PIH to reflect the consequence that under rational expectation, consumption is a martingale and changes in consumption are unrelated to anticipated changes in income. However, the implementation of this test is subject to several strong assumptions that are not applicable for farm households. For example, the liquidity constraint experienced by the low-wealth group may well lead to evidence against excess sensitivity test (Zeldes, 1989).

On the other hand, if we define saving s_t as

$$s_t = r/(1+r) A_t + y_t - c_t \quad (2.7)$$

When we equate the consumption c_t in (2.3) and (2.7) and take the terms of expected income out, we have

$$s_t = - \sum_{k=0}^{\infty} (1+r)^{-k} E_t \Delta y_{t+k} \quad (2.8)$$

This is the saving version of PIH, which is interpreted as a statement that “*people save when they expect their income to decline and borrow when they expect income to increase*” (Jappelli & Pistaferri, 2010, p. 484).

Now if we assume income process to be difference-stationary with mean μ and the white noise ϵ such that $y_t - \mu = \epsilon_t + \beta_t \epsilon_{t-1}$ we can use the moving-average representation to write

$$\Delta y_t = \mu + \sum_0^\infty \beta_k \epsilon_{t-k} \quad (2.9)$$

where μ is the trend rate of change and β_0 taken to be unity. When we allow $\beta_1 = -1$, we can test the restriction of PIH by analysing the following vector autoregression between saving and the change of income:

$$\begin{pmatrix} \Delta y_t - \mu \\ s_t \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} \begin{pmatrix} \Delta y_{t-1} - \mu \\ s_{t-1} \end{pmatrix} + \begin{pmatrix} u_{1t} \\ u_{2t} \end{pmatrix} \quad (2.10)$$

If we write the change in income as:

$$\Delta y_t - \mu = \alpha_1 (\Delta y_{t-1} - \mu) + \alpha_2 s_{t-1} + u_{1t} \quad (2.11)$$

where α_1 and α_2 are the elements in matrix in (2.10).

The PIH restriction implies that saving equation should take the form:

$$s_t = \alpha (\Delta y_{t-1} - \mu) + (\beta + 1 + r) s_{t-1} + u_{2t} \quad (2.12)$$

From (2.7), we can work out the change in consumption as:

$$\Delta c_t = \Delta y_t + (1 + r) s_{t-1} - s_t \quad (2.13)$$

When we use (2.11) and (2.12) to substitute into (2.13), we have:

$$\Delta c_t = u_{1t} - u_{2t} \quad (2.14)$$

The change in permanent income is

$$\Delta y_t^P = \sum [(1 + r)^{-1}]^k (E_t - E_{t-1}) \Delta y_{t+k} = u_{1t} - u_{2t} \quad (2.15)$$

From (2.14) and (2.15) the change in consumption equals the change in permanent income.

This is the basis of *excess smoothing test* proposed by Campbell and Deaton (1989) that consumption should not be smoothed against permanent income.

As commented by Deaton (1992, p. 130), both excess sensitivity test and excess smooth test are:

“not different, but two aspects of the same phenomenon. If consumption changes are orthogonal to lagged information [on transitory income], then they must be equal to changes in permanent income, and they cannot be too smooth. Correspondingly, if

the change in permanent income and the change in consumption are equal, then consumption is a random-walk and there is no excess sensitivity”.

From these derivations, many tests have been developed to validate PIH. The first approach generally is based on *excess sensitivity test*. Literature following this approach tests the responses of consumption to anticipated income changes. Even after distinguishing between income decreases and income increases, the conclusions have not reached consensus. The second approach generally is based on *excess smoothing test*. Literature following this approach distinguishes permanent from transitory components of income and tests the responses of consumption to these components. Both trends of literature suffer from many limitations in their tests (Jappelli & Pistaferri, 2010). The limitations mainly are due to both empirical and theoretical challenges of PIH. Theoretically, to satisfy (2.1), the following assumptions have to be made: preferences are inter-temporally separable; felicity functions are quadratic; there is no liquidity constraint such that a consumer can borrow and save at a constant real interest rate. All of these assumptions are subject to validation. Empirically, it is difficult to identify if the econometrician can observe anticipated income changes or unanticipated income shocks.

Literature on PIH provides important implications for research on responses to income shocks. Jappelli and Pistaferri (2010, p. 483) generalised (2.6) and (2.14) to be the following expression of consumption changes:

$$\Delta c_t = \sum_{i=1}^N \phi^i \pi_t^i \quad (2.16)$$

where the income process has N different components, and each differs in its degree of persistence. The coefficient ϕ^i measures the effect of the innovation of the i^{th} income component on consumption changes. With regards to income shocks, an interpretation of this generalisation is that according to PIH, consumption is smoothed against transitory

shocks, namely the innovation of transitory components, but not against permanent shocks, namely the innovation of permanent components of income.

Notably, in order to derive (2.1), the assumption of no liquidity constraint (perfect credit market) is made with another assumption of no insurance market with contingent assets. Consumers therefore depend on their own resources to smooth their consumption against changes in income. These strategies are referred to as self-insurance mechanisms that include accumulation of savings and assets, and the corresponding depletion when income shocks happen.

The self-insurance strategies are distinguished from the tendency to save more in the event of income uncertainty, namely *precautionary saving*. As can be seen from (2.8), saving happens only when the consumer expects an income reduction, and depends on expectation, rather than variance of income. Saving behaviours should not change when income becomes more uncertain. However, using the same assumed quadratic utility model, the first order condition for utility maximisation can be derived as (Jappelli & Pistaferri, 2010, p. 484):

$$\Delta \ln c_t = \gamma/2 \text{var}_{t-1}(\Delta \ln c_t) + \xi_t \quad (2.17)$$

where γ is the coefficient of relative risk aversion $U(c) = c^{1-\gamma}/(1-\gamma)$, and ξ_t is a forecast error in consumption growth. The coefficient of relative prudence in the iso-elastic preferences (assumed) is $-c \frac{U'''(c)}{U''(c)} = (1 + \gamma)$. The derivation of (2.17) is further based on the assumptions that the interest rate is constant and equal to the intertemporal discount rate, and consumption is log-normally distributed. An interpretation of (2.17) is that with the presence of precautionary saving, consumers will save more than what PIH predicts ($\gamma > 0$). Precautionary saving therefore can lead to a reduced effect of permanent shocks

on consumption (see Carroll and Christopher, 2009; Kaplan and Violante, 2010 in Jappelli and Pistaferri (2010)).

2.2.2 Complete Market Hypothesis(CMH)

The seminal works on CMH are Mace (1991) and Cochrane (1991). Mace (1991) described a model of risk-sharing in the setting of a social planner, who maximises the weighted sum of the expected utilities of J individuals in a community²

$$\sum_{j=1}^J w^j \sum_{t=0}^{\infty} \delta^t \sum_{\tau=1}^S p(S_{\tau t}) U[c_t^j(S_{\tau t}), b_t^j(S_{\tau t})] \quad (2.18)$$

subject to an aggregate resource constraint:

$$\sum_{j=1}^J c_t^j(S_{\tau t}) = \sum_{j=1}^J y_t^j(S_{\tau t}) \quad (2.19)$$

In specification (2.18), w^j refers to the Pareto-efficient weight of consumption allocation that the social planner assigns to each individual in the community that remains unchanged over time. w^j satisfies the following conditions: $0 < w^j < 1$ and $\sum_{j=1}^J w^j = 1$. δ is the discount factor with $0 < \delta < 1$. $S_{\tau t}$ refers to a state τ at time t and $p(S_{\tau t})$ denotes the probability of of such state. $p(S_{\tau t})$ satisfies the following conditions: $0 \leq p(S_{\tau t}) \leq 1$ and $\sum_{j=1}^J p(S_{\tau t}) = 1$. $U[c_t^j(S_{\tau t}), b_t^j(S_{\tau t})]$ refers to the utility of individual j 's consumption in state $S_{\tau t}$ and a preference shock $b_t^j(S_{\tau t})$.

In specification (2.19) $y_t^j(S_{\tau t})$ refers to the endowment of the consumption good of individual j at state $S_{\tau t}$.

Assuming exponential utility function: $[C_t^j, b_t^j] = -1/\sigma \exp[-\sigma(C_t^j - b_t^j)]$, $\sigma > 0$

² Jalan and Ravallion (1999) used the term *coinsurance group* to describe the group of people/households who share risks. Earlier, Townsend (1994) used an Indian village as the unit of full insurance analysis. Grimard (1997) in Hooegeveen (2002) however showed that ethnic group is more appropriate basis than residence in the same village for analysing full insurance. Here, we flexibly use the simple term of *community* to refer to the group of people who share risk so that it can accommodate different geographical and non-geographical bases.

with DARA σ , Mace (1991) showed that for:

$$w^a = \frac{1}{J} \sum_{j=1}^J \log w^j; c_t^a = \frac{1}{J} \sum_{j=1}^J \log c_t^j \text{ and } b_t^a = \frac{1}{J} \sum_{j=1}^J \log b_t^j,$$

consumption for individual j is:

$$c_t^j = c_t^a + \frac{1}{\sigma} (\log w^j - \log w^a) + (b_t^j - b_t^a) \quad (2.20)$$

Assuming power utility function $U[c_t^j, b_t^j] = \exp(\sigma b_t^j) 1/\sigma (c_t^j)^\sigma$ with CRRA $(1 - \sigma)$,

Mace (1991) showed that for:

$$w^a = \frac{1}{J} \sum_{j=1}^J \log w^j; c_t^a = \exp\left(\frac{1}{J} \sum_{j=1}^J \log c_t^j\right) \text{ and } b_t^a = \frac{1}{J} \sum_{j=1}^J \log b_t^j,$$

consumption for individual j is:

$$\log c_t^j = \log c_t^a + \frac{1}{1-\sigma} (\log w^j - w^a) + \frac{\sigma}{1-\sigma} (b_t^j - b_t^a) \quad (2.21)$$

Taking first difference of both (2.20) and (2.21) shows that both changes in consumption and consumption growth depends on the community's aggregate consumption changes and growth, net of preference shock.

$$\Delta c_t^j = \Delta c_t^a + (\Delta b_t^j - \Delta b_t^a) \quad (2.22)$$

$$\Delta \log c_t^j = \Delta \log c_t^a + \frac{\sigma}{1-\sigma} (\Delta b_t^j - \Delta b_t^a) \quad (2.23)$$

Derivation of (2.22) and (2.23) is possible under the assumptions of separability of consumption and leisure, additive preferences over time and across states, and common rate of time preference. Without the preference shock $b_t^j(s_{tt})$, there will be perfect co-movement between individual consumption and the community's aggregate consumption. An interpretation of the preference shock in Mace's model therefore is the shock effect specific to an individual that causes different changes in each individual's marginal utility of consumption.

Full Insurance Theory by Townsend (1994, pp. 584-585) adopted a similar approach of Pareto-efficient consumption allocation with modifications of the model specification.

Deaton (1992) took a different approach by describing the existence of contingent transfers rather than consumption allocation weight. Deaton (1992) specified the CMH as the benchmark model where risk-sharing exists such that individual consumption responds to aggregate risk but not to idiosyncratic risk. Intuitively, individuals in a community have different levels of consumption because of different individual marginal utilities and will spread risks by sharing their good and bad fortunes. Deaton (1992, p. 35) described a *complete* market as the one where “*each state of nature can be insured against by buying or (selling) the appropriate security*”. The individual has a master plan of consumption, including the contingency plans for each possible state of the world. The viability of the contingency plans is guaranteed by the existence of such a complete market. While Mace (1991) assumed a constant Pareto-efficient weight of consumption allocation, Deaton (1992) assumed an unchanged master plan of consumption for each individual. To create such a complete market, Deaton (1992) used a complete set of *Arrow securities*, each of which promises a unit return if state τ occurs in period t , against payment now of a price $P_{\tau t}$. Using the same notation of state $S_{\tau t}$, which refers to a state τ at time t , and the probability of state $p(S_{\tau t})$, the objective is to maximise the lifetime utility

$$\sum_{\tau=1}^S \sum_{t=1}^T p(S_{\tau t}) U[c_t^j(S_{\tau t})] \quad (2.24)$$

subject to the lifetime budget constraint in (2.2) for individual j is:

$$\sum_{\tau=1}^S \sum_{t=1}^T (1+r)^{-t} P_{\tau t} c_{\tau t}^j = A_1^j + \sum_{\tau=1}^S \sum_{t=1}^T (1+r)^{-t} P_{\tau t} y_{\tau t}^j \quad (2.25)$$

In this specification, $y_{\tau t}^j$ is labour income in period t at state τ .

The first order optimisation condition for (2.24) subject to (2.25) is

$$\lambda_t(c_{\tau t}^j) = \theta^j \left(\frac{\delta^{-1}}{1+r} \right)^t \frac{P_{\tau t}}{p(S_{\tau t})} \quad (2.26)$$

where θ^j is Lagrange multiplier for individual j , δ refers to the time preference coefficient in the following such that $U_t(c_t) = \delta^t U(c_t, z_t)$ with z_t being variables that affect the desirability of consumption at different points in the life cycle (or the taste shifters). Similar to Mace (1991), Deaton (1992) assumed that all individuals have a common rate of time preference.

Compared to Mace (1991) who assigned a constant weight to each individual's consumption allocation, Deaton (1992) nominalised both income and consumption of individuals using the single numeraire P_{tt} . Both approaches lead to the same effect where individual consumption is affected by the aggregate, rather than idiosyncratic shocks.

Specifically, similarly to Mace (1991), Deaton (1992) shows that when assuming CRRA

$$U(c_j) = \frac{c_j^{1-\sigma}}{1-\sigma},$$

$$\ln c_t^j = -\sigma^{-1}(\ln \theta^j - \ln f(z_t) + \ln \iota_t) \quad (2.27)$$

where $\iota_t = \left[\frac{\delta^{-1}}{1+r} \right]^t \frac{P_{tt}}{p(s_{tt})}$ and $f(z_t)$ refers to the function of taste shifters.

(2.27) is almost identical to (2.23) in proving that individual consumption depends on aggregate factors, net of preference shocks. Change in consumption depends on the price of contingent claims, the state probability and other changes in preferences that may result from the impact of shocks.

The idea of transfers flowing from individuals receiving positive income shocks to those receiving negative shocks is considered “unrealistic” (Jappelli & Pistaferri, 2010, p. 486) because of asymmetric information and contract enforcement problems. Individuals who receive positive shocks have an incentive to walk away from the transfer commitment and tend to misreport their shocks. Indeed, Deaton (1992, p. 37) commented that “*full risk*

pooling is only likely to occur among close-knit groups of individuals where people can be monitored or are fully trusted by one another”.

2.2.3 Comparing PIH and CMH

As commented by Mace (1991, p. 929), CMH is considered a stronger version of consumption smoothing against shocks than PIH:

“The current research is closely related to the literature on the permanent income hypothesis (PIH). In contrast to the PIH, all changes in idiosyncratic income, both permanent and transitory, are insured in the current risk-sharing model. Hence the current model can be viewed as an extreme version of the PIH.”

Jacoby and Skoufias (1998) also pointed out that with complete market, consumption will not respond to idiosyncratic changes in income, whether anticipated or not. As a result, they proposed to use unanticipated idiosyncratic shocks to test consumption smoothing in order to distinguish CMH from PIH. According to CMH, these idiosyncratic shocks will be smoothed. According to PIH, because these shocks are not anticipated, they will not be smoothed.

However, it can also be deduced that aggregate anticipated shocks are predicted to be smoothed by PIH, but not by CMH. The strength of these hypotheses therefore should not be considered from the consumption smoothing perspective, but from the perspective of what assumptions are involved. Apart from the assumption of separability of consumption and leisure, PIH assumes perfect credit market and CMH assumes homogenous preference. CMH has stronger assumptions because it further assumes the existence of a perfect insurance market, which it is assumed to lack according to PIH.

In terms of derivation, it is interesting to put side by side (2.16) and (2.22), (2.17) and (2.23). Comparison of (2.16) and (2.22) shows that in order for both PIH and CMH to hold,

idiosyncratic shocks are transitory, and aggregate shocks are permanent. Comparison of (2.17) and (2.23) shows that consumption growth is determined by both consumer preferences and aggregate shocks. The identity further points to the effect of aggregate shocks on risk preference.

2.3. The Asset Smoothing Theory

Asset smoothing can be loosely described as the tendency to maintain consistent levels of assets despite income changes, at the cost of sacrificing consumption smoothing. As can be seen, Asset Smoothing Theory (AST) assumes the opposite of consumption smoothing theories: households aim to smooth assets, rather than consumption. However, the asset smoothing behaviours can be explained by many motivations that are still within the framework of consumption smoothing theories. Zimmerman and Carter (2003) can be considered pioneers in proposing an alternative motivation for households in exhibiting asset smoothing behaviours. We therefore divide this section into two parts. The first part, namely *alternative explanations of asset smoothing behaviours*, summarises reasons why households choose to smooth assets at the cost of sacrificing consumption, but still pursue the consumption smoothing aim. In other words, assets are considered a buffer strategy for consumption smoothing. The second part presents initial ideas of Zimmerman and Carter (2003) and subsequent developments. The divergence of AST from PIH and CMH mainly came from the recognition of non-traditional features of utility function, production function and labour market.

2.3.1 Alternative Explanations of Asset Smoothing Behaviours

Precautionary saving, an extensively explored concept in the literature, is one of the reasons why household smooth assets rather than smooth consumption. Deaton (1992) described this as the reason why consumption behaviours are different from those predicted by PIH.

Precautionary saving, as a result of prudence in (2.17), can lead to a situation where individuals *deliberately* reduce their consumption rather than smooth consumption as explained below:

“Consumers who have low incomes and low assets early in their life cycle face greater consumption uncertainty in the future than do those with high incomes or high assets, simply because they have fewer resources, and are less well insured, and so should plan to postpone consumption” (Deaton, 1992, p. 194)

However, this tendency is still within the framework of considering assets as a buffer stock, which is in effect a self-insurance strategy implied in PIH.

Another reason is the lack of well-functioned markets. Hooegeveen (2002) pointed out that in developing economies, safe savings instrument as assumed by Deaton (1989) and Deaton (1991) are usually scarce. When income shocks happen, the increased supply of buffer assets leads to decreased asset market prices. Therefore, depletion of assets as a self-insurance strategy is not advantageous, and *“a household that reduces consumption still behaves rationally”* (Hooegeveen, 2002, p. 113).

Both explanations describe the tendency to defer assets depletion to maximise the benefit of using buffer assets for smoothing consumption. McPeak (2004) however pointed to a different direction of explaining asset smoothing behaviours. He distinguished asset shocks from income shocks. He showed that asset shocks in the absence of income shocks will cause households to smooth assets. Income shocks in the absence of asset shocks will cause households to deplete assets to smooth consumption. When both asset shocks and income shocks happen, depending on which effect is the larger, households will either smooth assets or consumption accordingly.

Other explanations include the positive correlation of income shocks over time by Deaton (1992, p.188) and the decreasing relative risk aversion (DRRA) and decreasing absolute risk aversion (DARA) proposed by Rosenzweig and Binswanger (1993, p. 61). Positive correlation of income shocks over time will lead consumers to smooth assets rather than smooth consumption because they expect the next period is likely to be even worse. DARA and DRRA will lead individuals in lower percentiles of wealth to destabilise their consumption more than do individuals in higher percentiles of wealth. Again, these explanations look at the characteristics of individuals and shocks, rather than assets as in the section below.

2.3.2 Micawber Threshold

The model proposed by Zimmerman and Carter (2003) differs from the traditional consumption smoothing model in that it has a non-convex relationship between consumption and utility. Other authors have attempted to create a similar non-convexity in the functional forms. Carter and Lybbert (2012, p. 257) noted three examples of such models:

- (i) Models that assume a subsistence consumption level that leads to non-convex utility function (Zimmerman & Carter, 2003)
- (ii) Models that assume a non-convex relationship between income generation and different levels of assets due to the fixed-cost constraint (Banerjee & Newman, 1994; Barrett, Carter, & Ikegami, 2008)
- (iii) Models that assume a non-convex functional form between consumption and work capacity (Ray & Streufert, 1993)

The first two models lead to asset smoothing behaviours that are motivated by the productive nature of the assets. The last model, however, argued against the asset

smoothing behaviours by pointing out that this option of behaviour is not attractive because of the endogenous survival and employment opportunity (Ray & Streufert, 1993, p. 73). We therefore focus on the first and second models.

Zimmerman and Carter (2003) developed the model in the setting of low-income economies. These countries are characterised by the lack of both perfect credit and insurance markets, two key assumptions of PIH and CMH. However, within these economies, incomes are widely distributed so that we can distinguish the rich from the poor households. They specified the following important four features of the economic environment (Zimmerman & Carter, 2003, p. 234):

- (1) Households save both in the form of conventional buffer assets (e.g., grain stocks and other safe saving instruments) and in the form of productive assets. Accumulation of buffer assets comes at the opportunity cost of productive assets, as well as at the cost of forgone consumption;
- (2) Markets for productive assets (e.g, land and livestock) are localised with prices locally determined;
- (3) Household income is subject to covariant as well as to idiosyncratic shocks, creating the possibility that local asset prices may endogenously move with transitory income;
- (4) Subsistence risk is nontrivial, especially for poorer villagers.

Compared to previous works, Zimmerman and Carter (2003) gave more attention to the characteristics of assets. They distinguished productive assets, for example lands, from buffer assets, for example grains. In their model, the productive assets are characterised by risky but high returns (denoted M) and the buffer assets by risk-free but low returns (denoted N). Because of liquidity constraint, $M \geq 0$ and $N \geq 0$.

The production function is:

$$F(T_{it}, N_{it}, \emptyset_{it}, \emptyset_{vt}) = \emptyset_{it} \emptyset_{vt} D \cdot (M_{it})^\eta + \Gamma N_{it} \quad (2.28)$$

where M_{it} is household i holding of the productive asset in period t ; N_{it} is the holding of the buffer asset with the rate of return Γ ; D is productivity parameter of the productive asset and η is the decreasing return of the output elasticity parameter; \emptyset_{it} refers to the idiosyncratic shock that affect household i at time t only and \emptyset_{vt} refers to the covariant shock that affect an entire village where the household reside.

The household i aims to maximise the following utility:

$$\max_{(c_{i0}, M_{i1}, N_{t1})} E_0 \left(\sum_{t=0}^{\infty} \delta^t u(c_{it}) \mid \chi(P_{Tt}, \emptyset_{vt} \mid \Omega_0) \right) \quad (2.29)$$

Subject to the constraint:

$$c_t \leq F(M_{it}, N_{it}, \emptyset_{it}, \emptyset_{vt}) - P_{Mt}(M_{it+1} - M_{it}) - (N_{it+1} - N_{it}) \quad (2.30)$$

where P_{Mt} is the price of the productive asset in period t ; the price is affected by the covariant shock and $\chi(P_{Mt}, \emptyset_{vt} \mid \Omega_t)$ is the joint distribution of the productive asset price and the covariate shock; Zimmerman and Carter (2003) assumed the buffer asset to have the numeraire price.

Equation (2.29) can be rewritten as:

$$\max_{(c_0, M_1, N_1)} (u(c_0) + \delta J^*(M_1, N_1, L_1)) \quad (2.31)$$

where $t = 0$ and given $M_0, N_0, \emptyset_{i0}, \emptyset_{v0}$; $J^*(M_0, N_0, L_0) = L_0 E_0 \left(\max_{(c_0, T_1, M_1)} \sum_{t=0}^{\infty} \delta^t u(c_t) \right)$

represents the value of the problem in the future and the state variable L reflects the intertemporal dependence of future utility on past consumption. Specifically, the state variable L_τ equals 0 if consumption is smaller than the substance minimum R_0 (the subsistence minimum) in the past (before period τ) and 1 if otherwise.

If the true value function J^* can be known, the asset allocation problem is solved by setting:

$$\frac{1}{P_{T\tau}} J_1^*(T_{\tau+1}, M_{\tau+1}, L_{\tau+1}) = J_2^*(T_{\tau+1}, M_{\tau+1}, L_{\tau+1}) \quad (2.32)$$

And the consumption-investment trade-off is solved by setting:

$$u'(c_\tau) = \delta J_1^*(M_{\tau+1}, N_{\tau+1}, L_{\tau+1}) \quad (2.33)$$

where J_i^* is the first derivative of J^* with respect to the i th argument.

Zimmerman and Carter (2003) specified the utility function to be

$$u(c_{it}) = \begin{cases} (c_{it}/R_0)^\zeta & \text{if } c_{it} \geq R_0 \text{ and } c_{i\tau} \geq R_0 \text{ for all } \tau \in \{1, 2, \dots, t-1\}, \zeta < 1 \\ 0 & \text{otherwise} \end{cases} \quad (2.34)$$

and use numerical simulation to calculate the true value function, using 1981-1985 ICRISAT data and parameters estimated by Carter (1997).

They subsequently found three types of strategies

- (1) The zero-wealth position: the household generates no income and suffers from a subsistence crisis
- (2) The defensive strategy: the household pursues asset smoothing with a conservative, low-yield asset portfolio
- (3) The entrepreneurial strategy: the household pursues consumption smoothing. The asset portfolio not only has a higher yield but also acts more as buffer stock.

Comparison of the defensive strategy to the entrepreneurial strategy shows that the former is associated with poorer households with smaller values of asset portfolios (the poor), and the later wealthier with higher values of asset portfolios (the rich). The poor clearly show a tendency to smooth assets and destabilise consumption, whereas the rich do the opposite. Zimmerman and Carter (2003) further noticed that two different strategies correspond to two partitions of the initial asset spaces. They borrowed the concept of *Micawber Threshold* from Lipton (1994) to distinguish two groups of household: the households with asset levels above the Micawber Threshold will behave as predicted by consumption smoothing theory in using assets as buffer for consumption, and follow the entrepreneurial

strategy; the households with asset levels under the Micawber Threshold will use “*consumption to buffer assets in the wake of shocks - not the other way around*” and follow the defensive strategy (Zimmerman & Carter, 2003, p. 248).

The work by Zimmerman and Carter (2003) opened up a new hypothesis of solving the dynamic utility maximisation problem. As commented by them, “*the failure of the poor to smooth consumption may seem at first counterintuitive, especially in the context of a risk-management literature that often describes itself as a consumption-smoothing literature*” (Zimmerman & Carter, 2003, p. 248). In their simulation, households face shocks of the same nature and have the same preference. Therefore, the asset smoothing behaviours cannot be explained by the alternative motivations in section 2.1. The difference in the model is partly due to the subsistence consumption constraint R_0 in (2.34) that causes the poor to be more motivated to “*smooth income than the rich, and at the same time to take less of this stability in the form of consumption (and more in the form of protecting assets) than do the rich*” (Zimmerman & Carter, 2003, p. 251). Another reason is the asset price risk as mentioned by Hoogeveen (2002), where asset prices decrease due to increased supply of assets when covariant shocks happen. Zimmerman and Carter (2003, p. 250) themselves admitted that their model involves both income smoothing motives and asset price risk, but cannot quantify how much is due to what effect.

Barrett et al. (2008) imposed the constraint of cost in obtaining technology, rather than the constraint of subsistence consumption like Zimmerman and Carter (2003) did. They specified income generation process as a function of both innate ability of household i ($ability_i$) and the stock of capital at time t . For easy comparison with the model by Zimmerman and Carter (2003), we denote the capital as M_{it} because it has the same

characteristics. The production function is specified as the choice between high technology $f_H(ability_i, M_{it})$ and low technology $f_L(ability_i, M_{it})$:

$$f(\alpha_i, k_{it}) = \begin{cases} f_L(ability_i, M_{it}) = ability_i M_{it}^{\lambda_L} \\ f_H(ability_i, M_{it}) = ability_i M_{it}^{\lambda_H} - F \end{cases} \quad (2.35)$$

where $0 < \lambda_L < \lambda_H < 1$; F is the fixed cost required in the high technology so that this technology is not worth using at low amounts of capital.

The maximisation problem then becomes:

$$\begin{aligned} \max_{\{c_t, i_t\}} E_\tau \left(\sum_{t=\tau}^{\infty} \delta^t U(c_t) \right) \\ \text{s.t. } c_t + i_t \leq f(ability_i, M_{it}) \\ M_{it+1} = \vartheta_t [i_t + (1 - \kappa)M_{it}] \end{aligned} \quad (2.36)$$

where i_t equals investment in productive assets, ϑ_t represents the asset shocks that affect the future levels of assets but not current incomes and δ again is the discount factor and κ represents depreciation of the productive assets .

Barrett et al. (2008) then showed that this model will identify a critical asset level, denoted $\tilde{M}(ability)$ for each level of ability such that individuals with capital stock larger than $\tilde{M}(ability)$ will attempt to accumulate the assets to adopt the high technology, and those with capital stock smaller than $\tilde{M}(ability)$ will pursue the low technology. As the critical asset level, or Micawber Threshold, $\tilde{M}(ability)$ depends on an individual's innate ability, Barrett et al. (2008) used numerical analysis of the dynamic programming model to generate the Micawber Frontier for different levels of innate ability (Figure 2.1). There are two important takeaway messages from this figure. First, people with very low or very high ability or skills will behave differently from people with skill levels in the middle. People with very low skills cannot harness the technology no matter how much their capital is built up. People with very high skills can work their way forward even without the initial

endowment of capital. People whose skill levels are in the middle will choose to smooth assets to increase their productivity if their initial asset levels are above the Micawber Threshold. Secondly, the existence of asset shocks mean that people can be demotivated to pursue the asset accumulating strategy and therefore stay trapped in poverty. The shift from Micawber Frontier without risk to Micawber Frontier with risk means that when risks are present, an individual symbolised by the solid circle will not pursue high technology anymore because he or she is under the Micawber Threshold.

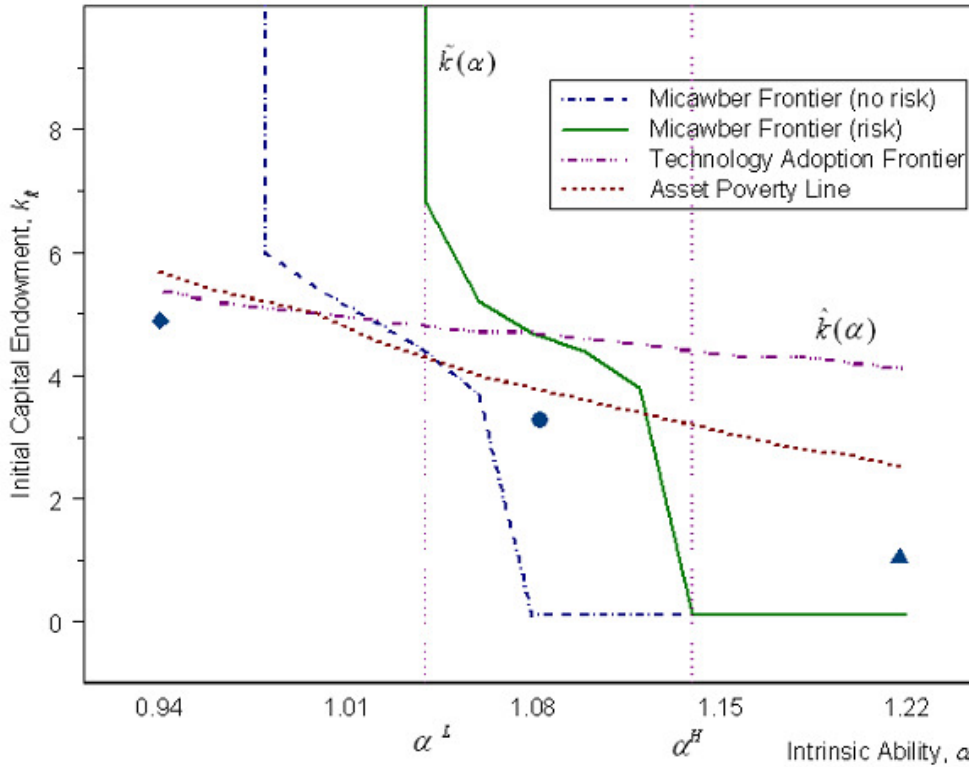


Figure 2.1: Risk and Micawber Threshold (reproduced from Barrett et al., 2008)

Note: α in Figure 2.1 is equivalent to *ability* in our specification above

Carter and Lybbert (2012) slightly modified the above model as follow:

$$\max_{\{c_t, M_t\}} E_\tau \left(\sum_{t=\tau}^{\infty} \delta^t U(c_t) \right) \quad (2.37)$$

$$s. t. c_t \leq f(M_t) + (1 - \kappa)\vartheta_t M_t$$

$$M_{t+1} = f(M_t) - c_t + (1 - \kappa)\vartheta_t M_t$$

$$f(M_t) = \max(f_L(M_t), f_H(M_t))$$

$$M_t \geq 0 \text{ for all } t$$

Similar to Barrett et al. (2008), Carter and Lybbert (2012) assume that the high technology is subject to a fixed cost such that the total output is higher under the low technology until a minimum level of capital is reached. Again, they assume asset shocks without income shocks and greater marginal returns under high, rather than low, technology. Problem (2.37) differs from problem (2.36) in that problem (2.37) assumes that households allocate their budget either to consumption or productive assets, and nothing else. On the other hand, problem (2.36) allows more flexibility in constraining $c_t + i_t \leq f(\alpha_i, M_{it})$, which means households can make spendings other than consumption and investment in productive assets. However, the modification made by Carter and Lybbert (2012) allows better comparison with the PIH problem. In particular, it can be seen that assets in PIH are assumed to yield a fixed, per-period rate of return r , while assets in AST are assumed to yield positive decreasing marginal return and are depreciated. Consequently, the function J of expected future value of holding assets is no longer concave in assets. As can be seen in the simulation in Figure 2.2, this value suddenly increases at a certain asset level that corresponds to the Micawber Threshold. At this point, an increase in value of assets becomes more strategic because in addition to the implied increase in income, households are able to escape their low-level equilibrium to reach higher-level equilibrium.

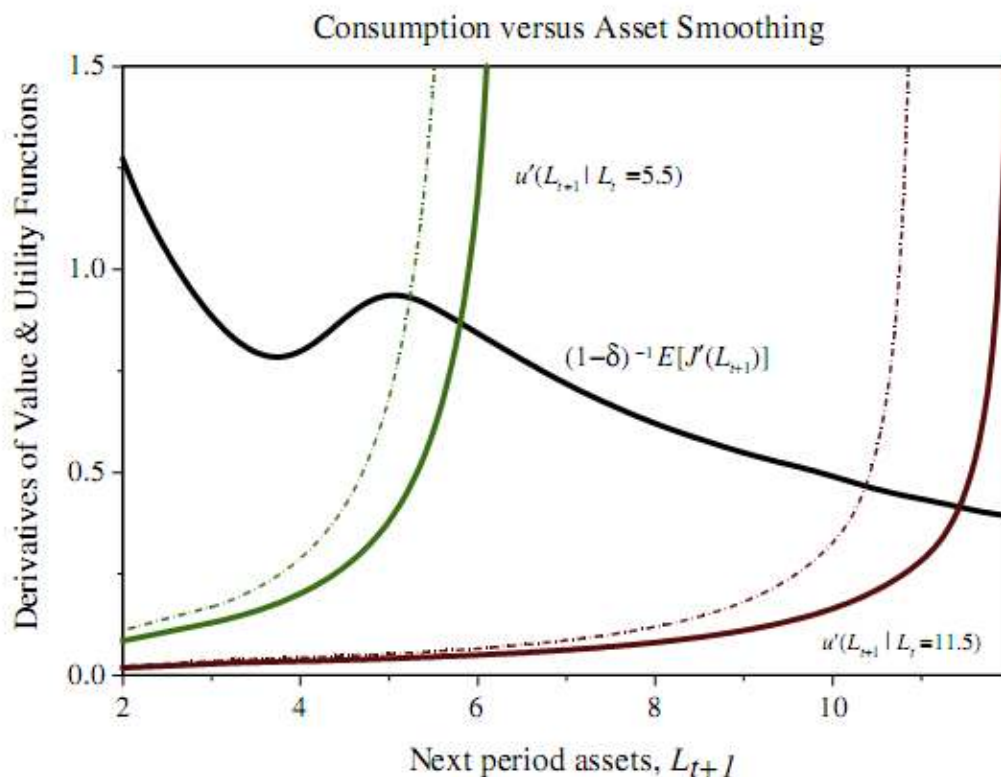


Fig. 1. Marginal intertemporal value and utility curves as a function of next period asset stock. The wiggle in the marginal value function with asset dynamics (solid downward sloping line) indicates the increased value of assets at the dynamic threshold. Marginal utility curves are drawn for high and low current asset levels. Dashed marginal utility curves indicate marginal utility after 10% reduction in assets.

Figure 2.2: Consumption versus Asset smoothing (reproduced from Carter and Lybbert, 2012)

AST can be considered a paradigm shift in risk-management literature from consumption smoothing to asset smoothing. This hypothesis was developed in the setting of developing countries characterised by low productivity and lack of perfect credit and insurance market. In this setting, people tend to destabilise consumption for two reasons. First is the autarkic saving, which refers to the deliberate increase in savings in anticipation of future bad outcomes. This behaviour is closely related to the precautionary motivation. Autarkic saving can destabilise the consumption, but still assets are considered as buffer stock. Second is the asset smoothing behaviour predicted by AST. In this case, assets are

considered as income-generating tools, not buffer stock. By imposing different constraints to create a non-convexity in the value function, AST literature shows that

“individuals would be willing to make substantial sacrifices of consumption to increase assets, and to pay a substantial penalty in terms of unsmooth consumption to protect assets and avoid falling below the critical asset threshold” (Carter & Lybbert, 2012, p. 258).

AST has opened up a new topic of development research by highlighting the existence of different equilibriums that can cause individuals to behave differently in the same setting.

2.4 Conclusion

In reviewing the predominant theories of consumption smoothing and asset smoothing, we highlight the following key points for subsequent empirical tests. First, the development of AST is in effect an extension of the traditional models used in developing consumption smoothing theories. Instead of considering general assets in the consumption smoothing models of PIH and CMH, asset smoothing model distinguishes between productive assets and buffer assets. The characteristics of productive assets motivate households to smooth income by making more investments, even at the cost of reduced consumption. Empirical tests of these models therefore require a good definition of productive assets in an appropriate production context. Second, we find that households motivated by consumption smoothing can smooth assets under many circumstances. Studies that compare the explaining power of AST versus PIH and CMH should take these circumstances into consideration. For example, it is important to consider if the lack of credit market leads households to self-insure using their buffer assets (Hoogeveen, 2002) and it is important to distinguish between asset shocks and income shocks (McPeak, 2004). Such requirements may cause difficulty in empirical tests, especially when both consumption smoothing and

asset smoothing tests are considered. From our review of theoretical frameworks used in consumption smoothing theories, the tests based on the responses of consumption towards observable negative shocks are able to provide such flexibility. Negative shocks form the transitory income changes that should have no effect on consumption according to PIH. We further can observe the covariate versus idiosyncratic nature of the shocks and determine the nature of shocks as income and/or asset shocks, which are used to test CMH and AST. Finally, in addition to the characteristics of assets, the literature on smoothing behaviours has highlighted the importance of consumer characteristics. Two such important characteristics are the innate ability and risk preference. Barrett et al. (2008) show that the motivation to smooth assets is closely related to the ability of producers. As can be seen from section 2.2, assumptions about risk preferences is the key to the extent of consumption smoothing in both PIH and CMH models. It is therefore crucial to consider these factors in an empirical analysis.

The following chapters will present the application of these theories to a sample representative of rural households in Vietnam. The next chapter provides a preliminary description of the sample.

CHAPTER 3

Regional and Temporal Variations in Shock Exposure and Livelihood Strategies

3.1 Introduction

Vietnam lies on the eastern margin of the Indochina peninsula with approximately 300,000 square kilometres. The country spans over 15 degrees of latitude from north to south, the west of the country is mountainous and the east flat and fertile, making agricultural production conditions and systems in Vietnam highly heterogeneous. The sample of rural households drawn from seven regions from north to south captures this heterogeneity. In this chapter, we first describe the location of the households and the data collection methods. We then compare the regional differences in terms of shock exposure, welfare and labour characteristics. We use the GSO classification for regional differences in climate, terrain and economic development: North West, North East, Red River Delta, Centre North, Central South, Central Highland and Mekong Delta. The northern regions are characterized by mountainous terrains whereas the central regions are characterized by the extensive exposure to coastal disasters. Two river deltas are characterized by flat planes with rich soils for agricultural activities. Regional characteristics are mapped to livelihood strategies and the roles played by formal and informal financial markets and public and private transfers. By comparing across regions and through time, we identify regions that consistently lag behind in terms of development.

3.2 Household Survey

The Vietnam Access to Resources Household Survey (VARHS) is a panel data survey managed jointly by three government institutes and funded by DANIDA.³ The pilot for the VARHS was administered in 2002 across 12 provinces in Vietnam. These provinces include four provinces supported by DANIDA under the Business Sector Program Support (BSPS) program (ex-Ha

³ Central Institute of Economic Management (CIEM) of the Ministry of Planning and Investment (MPI); Institute of Policy and Strategy for Agriculture and Rural Development (IPSARD) of the Ministry of Agriculture and Rural Development (MARD); and Institute of Labour Science and Social Affairs (ILSSA) of the Ministry of Labour, Invalids and Social Affairs (MOLISA).

Tay, Nghe An, Khanh Hoa and Lam Dong) and five provinces under the Agriculture Sector Program Support (ASPS) program (Dak Lak, Dak Nong, Lao Cai, Dien Bien and Lai Chau) and three other provinces (Phu Tho, Quang Nam and Long An). In 2006 the main survey re-surveyed 1,312 households in 12 provinces from the 2004 Vietnam Household Living Standard Survey (VHLSS). Another 126 households were randomly selected. In addition 886 of the households surveyed in 2002 as part of the pilot were re-surveyed. As a result, a total of 2,324 households were surveyed in VARHS in 2006. Since 2006, VARHS has been conducted every two years on the same sample of households with increases in sample size: 2006 (2,324 households), 2008 (3,269 households), 2010 (3,208) and 2012 (3,704). For the purpose of this thesis a panel data of 2,056 households is formed by pairing the codes of provinces, districts, communes and households between 2006 and 2008, 2008 and 2010, 2010 and 2012. The attrition rate is 3.7%. Compared to other household survey data, VARHS have several advantages. VHLSS contains information from all provinces in Vietnam, but the samples are not repeated and thus a panel data can not be constructed. The project Vulnerability in Southeast Asia conducted in University of Hannover, Germany includes repeated surveys of the same households in Thailand and Vietnam, but the sampled provinces are not as extensive as those in VARHS.

We apply the simple rule of excluding per capita income outliers with values more than three standard deviations from the sample mean (Osborne & Overbay, 2004). After that, we exclude households that are not present in all four survey waves and are left with 1,950 households in the balanced panel. We further exclude 35 households from the tourist province of Khanh Hoa. The final sample for analysis therefore is a balanced panel of 1,915 rural households in four survey waves in eleven provinces in Vietnam (Figure 3.1). It is noted that Ha Tay was merged into Hanoi, the capital, in 2008, and therefore appears on the map as Ha Noi. For ease of understanding, we use the old name of the province. We map eleven provinces to the corresponding seven regions: North

West (Lai Chau, Dien Bien Lao Cai); North East (Phu Tho); Red River Delta (Ha Tay); Centre North (Nghe An); Central South (Quang Nam); Central Highland (Dak Lak, Dak Nong, Lam Dong) and Mekong Delta (Long An).

VARHS includes both a commune survey and a household survey. The following is the main content of the household survey:

- (i) Cover page: surveyor, date and ethnicity/language
- (ii) Section 1: household roster, general characteristics of household members and housing
- (iii) Section 2: agricultural land
- (iv) Section 3: crop agriculture
- (v) Section 4: livestock, forestry, aquaculture, agricultural services, access to market and common property resources
- (vi) Section 5: employment, occupation, time use and other sources of income
- (vii) Section 6: extension services
- (viii) Section 7: food expenditures, savings, household durable goods
- (ix) Section 8: credit
- (x) Section 9: shocks and risk coping
- (xi) Section 10: social capital and network
- (xii) Section 11: migration
- (xiii) Section 12: trust, political connections, sources of information and rural society

The questionnaires for each specific survey wave and the corresponding data can be downloaded from the CIEM website (CIEM, 2017).

3.3 Shock Data Collection

VARHS contains questions about experience of shocks for the previous two years, beginning with the question: “*Since 1 July 20xx, did the household suffer from an*

unexpected loss from any of the following shocks?”. The other questions include information on the month and year of shocks occurrence, the damages and the coping strategy. The commonly cited shocks are natural disasters, health shocks (serious illness, injury or death of a household member), crop loss, animal diseases and input and output market shocks.

In addition to these self-reported shocks, we construct a matching weather database of typhoon occurrence and rainfall distribution. In particular, we track the movements of storm eyes from typhoon records (UNISYS, 2017) and match those to the sampled communes up to 250km from the eye of the typhoon, the typical typhoon radius (Ahrens, 1991). As can be seen from Figure 3.1, the Central provinces are most affected by typhoons. The Northern and Southern provinces of Phu Tho, Hanoi and Long An are less affected and no typhoons have ever landed on the mountainous provinces of the North West. From this dataset, we create a shock variable from the number of times when typhoons affected a particular commune in a year. Further communes are matched with the nearest weather station with monthly rainfall data for the 14 year sample period (MARD,2017). From the data, we define extreme rainfall events as those with more than three standard deviations, based on 14 years of monthly data, above the mean and classify each event as a shock event. Similarly, we use the data on animal disease outbreaks from the World Organization for Animal Health (OIE, 2017) to identify the affected communes within 10km from the location of the outbreaks, and construct a shock variable as the number of animal diseases outbreaks. Figure 3.1 shows the locations of our sampled households, the weather data variables and the outbreaks of animal diseases.

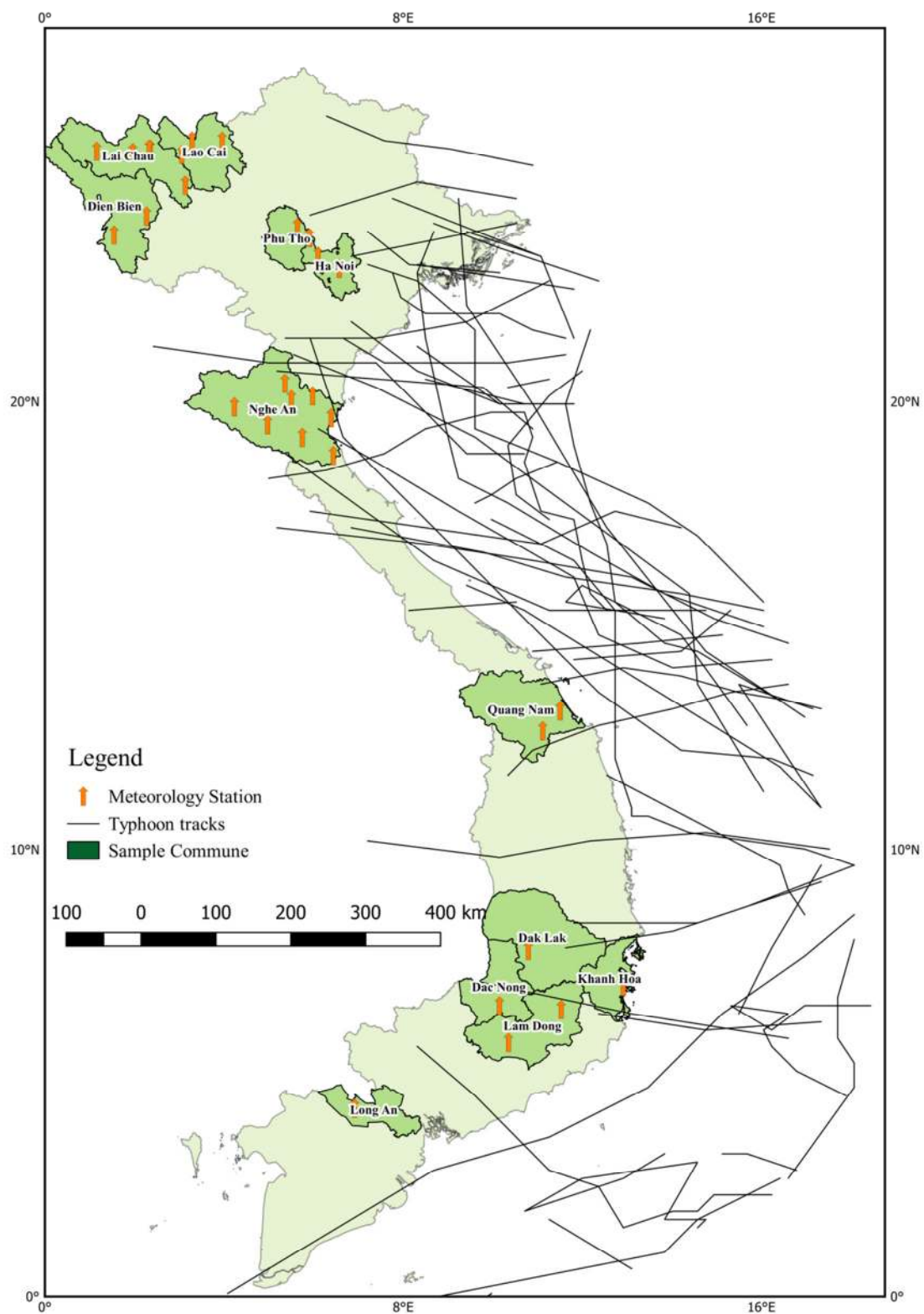


Figure 3.1 Map of the study sites and shock variables

3.4 Incidence of Shocks

We focus on the following four shocks: floods, animal diseases, crop diseases, health shocks. Floods, animal diseases and crop diseases are covariate shocks because they affect a group of households, whereas health shocks are idiosyncratic because they are specific to each household. As floods are most often caused by typhoons (Imamura & Van To, 1997), we consider the number of times typhoons affect a commune and the number of extreme rainfall events as a proxy for the flood events. We exclude cases where typhoons weaken and become tropical depressions, which are still likely to result in high rainfall levels. Occurrences of floods and animal diseases are recorded for the 12 months prior to the survey date. The self-reported crop disease is likely to affect all households in the community. To check this, a regression of the occurrence of crop disease on a seasonal and communal dummy explains 22% of the reported incidents, indicating that crop disease is indeed a covariate shock. The idiosyncratic shock variable is a measure of the household's health status. We calculate the effects of illness on the household from the number of days when household members reported they could not perform normal activities. We make use of the availability of exogenous data for natural disasters and animal diseases, and do not use self-reported records for these shocks. The advantages and disadvantages of using self-reported shocks are discussed in Chapter 4.

In Table 3.1, we compare the shock exposure of seven regions across time. OIE did not archive data for 2006 and VARHS did not include a questionnaire on lost working days in 2006. Therefore data on animal diseases and health shocks are not available in 2006. As can be seen, Central South and Central Highland are the most exposed to natural disasters. Northern areas and Red River Delta have rarely experienced flood and typhoon shocks. However, reported shocks show that on average all regions are hit by natural disasters once

every two years. Crop diseases and animal diseases occur frequently in all regions, whereas on average only 3% of total days are lost due to health shocks.

Table 3.1: Regional shock exposure 2006-2008

	Average Incidents							
	Floods				Self-reported natural disasters			
	2006	2008	2010	2012	2006	2008	2010	2012
North West	-	0.48	-	-	1.00	1.06	1.04	1.06
North East	-	-	-	-	1.00	1.10	1.25	1.06
Red River Delta	-	-	-	-	1.36	1.21	1.03	1.04
Centre North	-	1.30	-	-	1.76	1.08	1.21	1.17
Centre South	1.77	1.00	4.12	-	1.00	1.07	1.05	1.30
Central Highland	1.27	0.60	1.78	0.48	1.55	1.15	1.16	1.04
Mekong Delta	1.00	-	-	1.00	1.60	1.00	1.00	1.20
	Crop diseases				Animal diseases*			
North West	0.59	0.78	0.41	0.48	0.11	0.11	0.90	
North East	0.17	0.30	0.13	0.19	0.96	0.83	1.06	
Red River Delta	0.15	0.21	0.17	0.17	0.10	0.40	0.05	
Centre North	0.29	0.09	0.38	0.33	5.37	3.21	1.38	
Centre South	0.30	0.12	0.14	0.12	0.48	0.66	3.36	
Central Highland	0.29	0.28	0.62	0.12	0.12	0.15	1.49	
Mekong Delta	0.13	0.30	0.16	0.06	-	0.15	8.03	
	Health shocks (%)*							
North West					0.02	0.01	0.02	
North East					0.04	0.03	0.02	
Red River Delta					0.02	0.02	0.03	
Centre North					0.02	0.03	0.05	
Centre South					0.02	0.03	0.04	
Central Highland					0.02	0.03	0.02	
Mekong Delta					0.03	0.03	0.04	

* Information is not available for the year 2006

3.5 Household Welfare

3.5.1 Household Budgets

We define the household budget to be the sum of the following: *total income, public transfer, private transfer, new credit, dis-saving, depletion of assets, other income and other transfers*. Table 3.2 defines these variables. Except for asset transactions, all other transactions occur within the 12 months before the survey is administered.

Table 3.2: Description of budget items

Budget item	Description
Total income	Net income from agriculture, wages, business, exploitation of common property resources and rental activities.
Public transfers	Transfers from government and non-governmental organisations for income support, health care and educations.
Private transfers	Remittances from relatives and friends.
New credits	The loans made in the last 12 months.
Dis-saving	Reductions in savings in the last 12 months
Saving	Increases in savings in the 12 months before the survey
Depletion of assets	Reductions in the total value of assets in the 24 months before the survey
Investment in assets	Increases in the balances of assets in the last 24 months before survey time
Productive assets	Examples are boat, feed grinding machine, rice milling machine, grain harvesting machine, pesticide sprayers, tractor, plough, cart, car.
Consumer durable assets	Home facilities such as TV, radios, telephones, refrigerator, air conditioners etc. and vehicles (motorbikes and bicycles).
Total food expenditure	Fortnight food expenditure multiplied by 26

The following equation gives the budget identity:

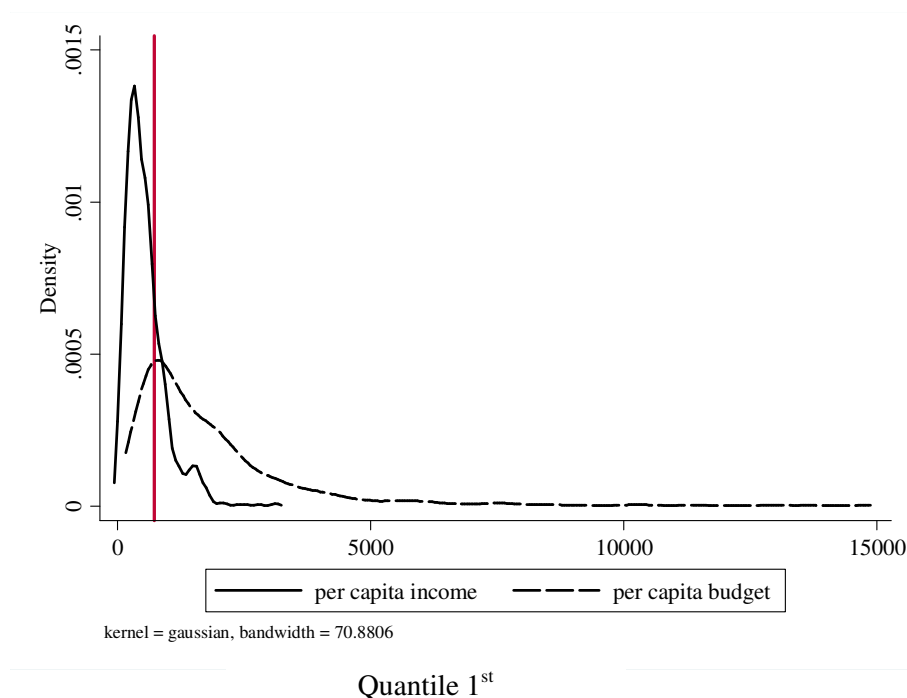
$$\text{Total income} + \text{Public transfers} + \text{Private transfers} + \text{New credits} + \text{Dis-saving} + \text{Depletion of assets} + \text{Other transfers} \equiv \text{Total food expenditure} + \text{Saving} + \text{Asset Investment} + \text{Other expenditure}.$$

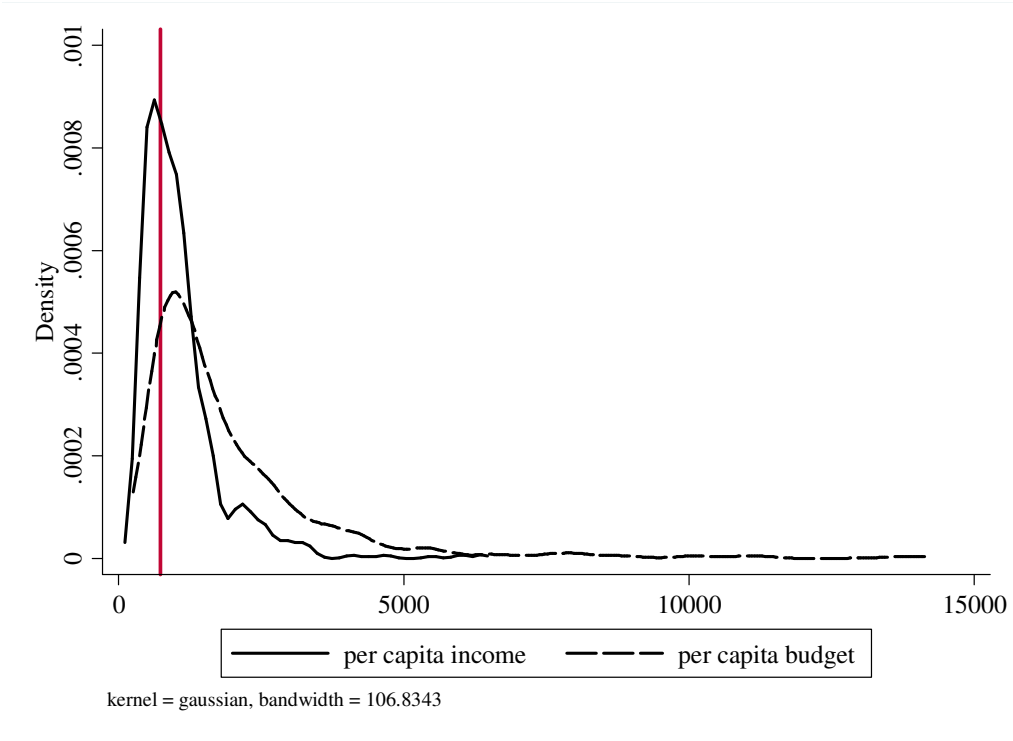
If total income is smaller than the budget, households deplete rather than invest in assets, and are net receivers of transfers. However, if total income is larger than the budget, household invest in rather than deplete assets and are net givers of transfers. We deflate the monetary values of these transactions to the 2010 value using the IMF information on Consumer Price Index (IMF, 2016).

Table 3.3: Deflation rates for monetary values

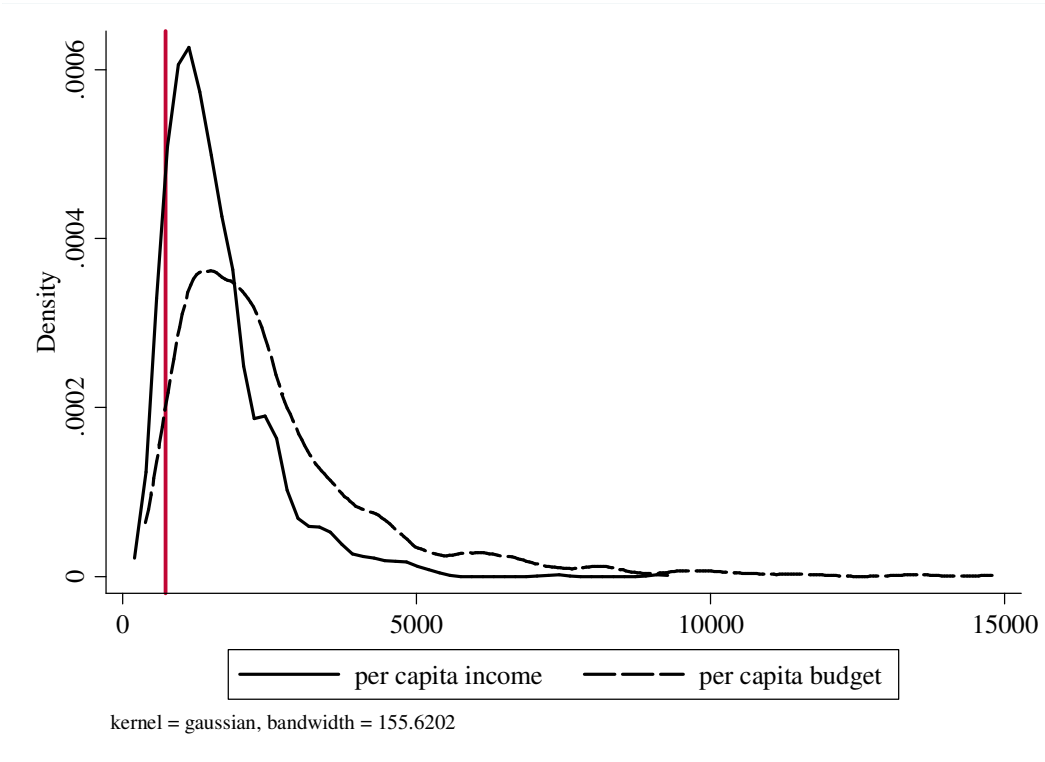
Year	IMF Consumer Price Index	Adjusting factor
	[1]	$[(1)/100+1]/[2010_1/100+1]$
2006	7.385786802	0.986443213
2008	23.11631629	1.130943472
2010	8.861600361	1
2012	9.094216	1.002136802

Figure 3.2 presents the distributions of per capita income (solid line) and per capita budget according to total income quantiles. Per capita income and budget are converted to USD using IMF PPP in 2010 (IMF, 2015). The straight line gives the poverty line 2US\$ per head per day. The majority of households in the lowest income quantile are below the poverty line. Their expenditure relies mostly on external transfers and therefore the budget distribution is flatter and lies above the labour income. As the quantiles of income increase two important trends are noted. First, the income and budget distributions both move further away from the poverty line. The proportion of households under the poverty line is very small in the 3rd quantile and there are almost no poor households in quantile 5th. Second, the distribution of income expands and gets closer to the budget line. For the group with the highest incomes in quantile 5th the labour income distribution is very close to, but still lies within, the budget distribution. Figure 3.2 shows that the sampled rural households are quite poor and the proportion of savings and investments made out of their labour income is small. They are “net receivers” of income rather than “net givers”.

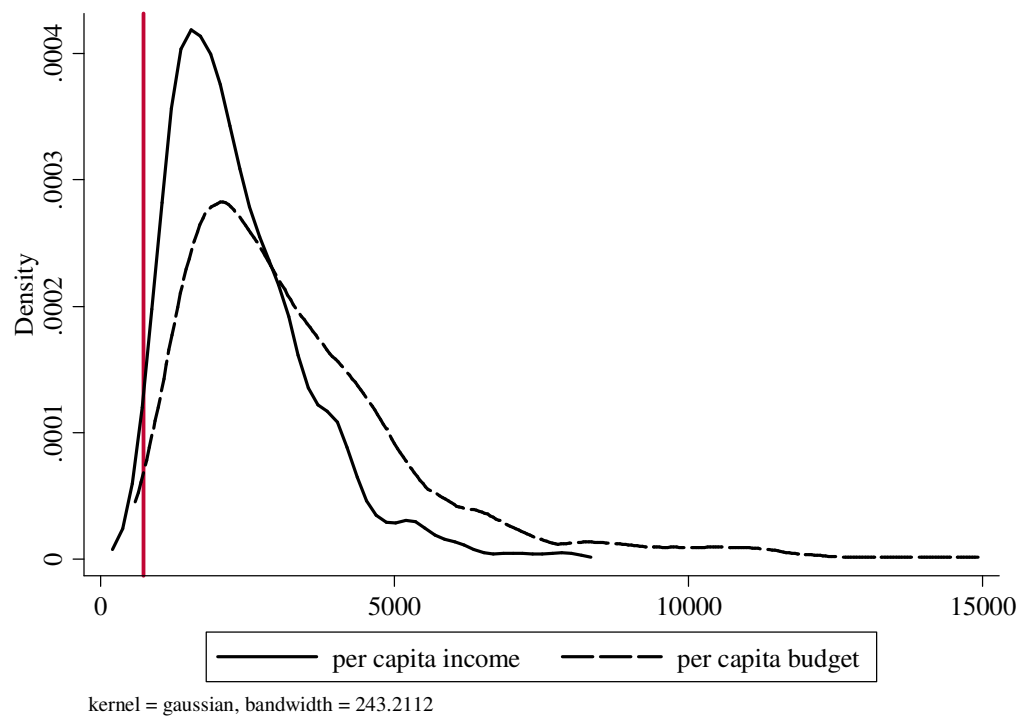
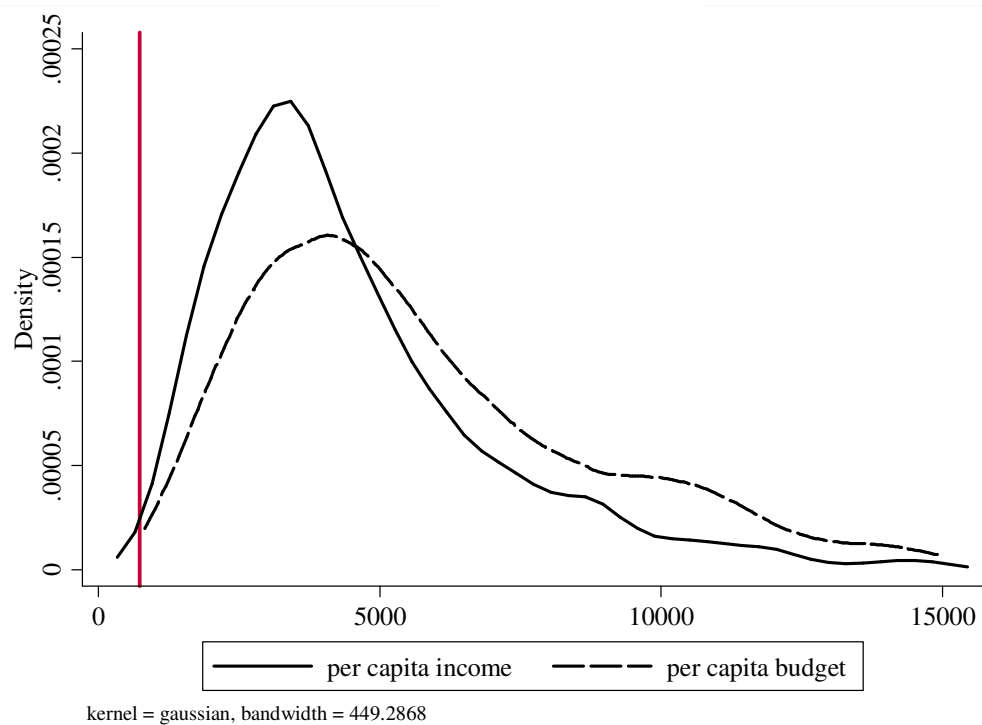




Quantile 2nd



Quantile 3rd

Quantile 4th

Quantile 5th

Figure 3.2: Distribution of income and budget of 5 quantiles of income

Table 3.4 presents the components of budget according to five quantiles of income for both the in-flow and out-flow of funds. As can be seen, labour income is still the main driver of the budget for all households, and the weight increases as income increases from quantile 1 to quantile 5. Households at the lowest ends derive only 42% of the budget from the earned income, while those at the highest ends rely on income for 2/3 of the total budget. The shortfall in total budget of the low-end households is covered by transfers, which decrease significantly as households improve their income. Transfers from public and private sources account for approximately 30% of the budget in quantile 1st but only 3% in quantile 5th. Borrowings are limited and surprisingly quite consistent across all income quantiles at approximately 10%. Access to finance is quite limited among poor rural households of Vietnam.

Table 3.4: Household budget percentage according to income quantiles (%)

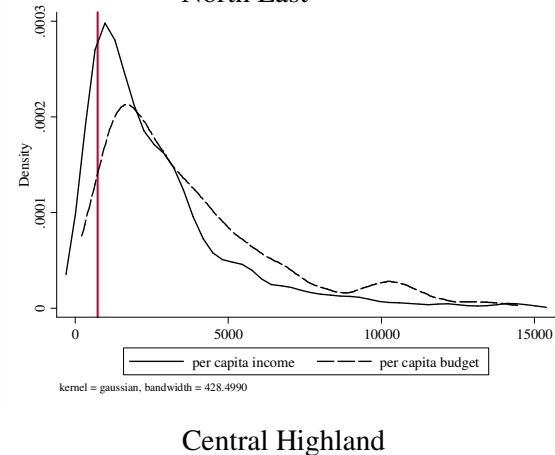
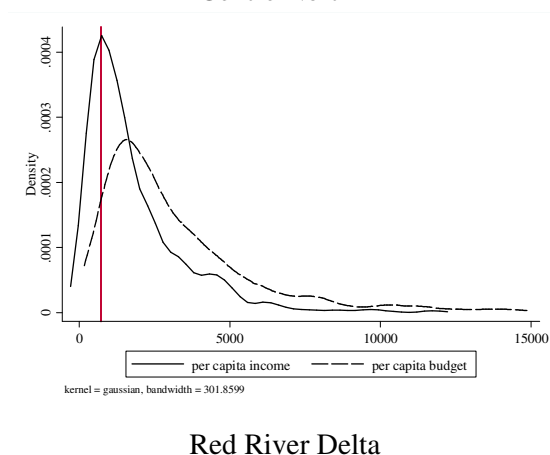
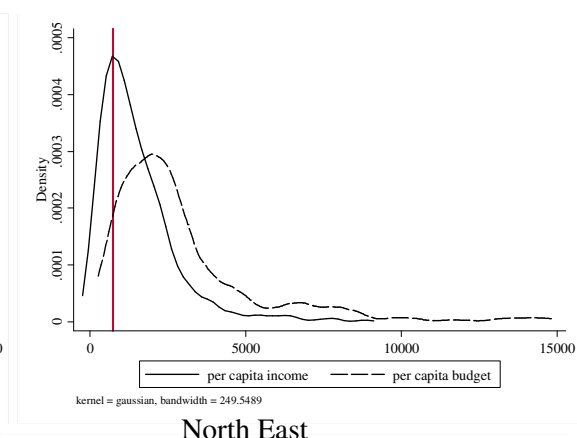
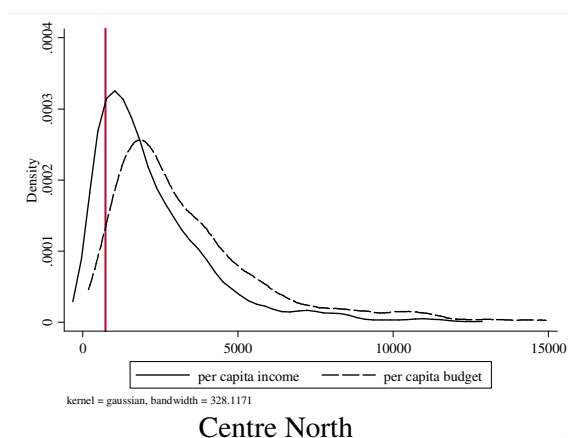
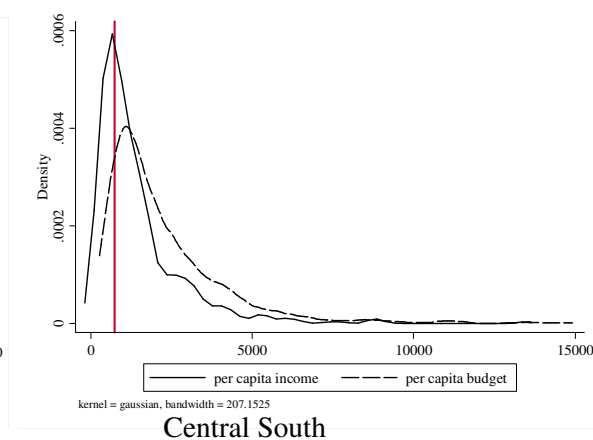
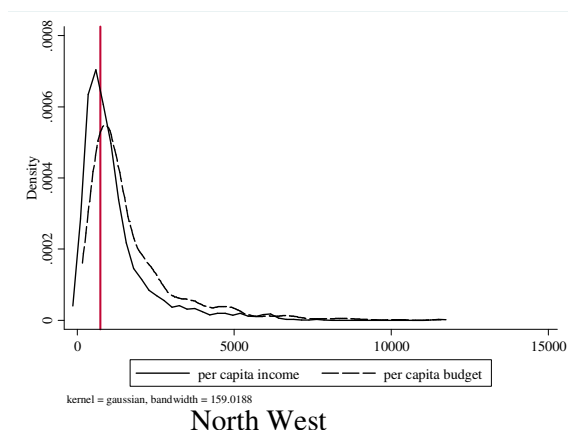
Cash-in	Q1 st	Q2 nd	Q3 rd	Q4 th	Q5 th	Cash-out	Q1 st	Q2 nd	Q3 rd	Q4 th	Q5 th
Labour income	42	65	70	74	76	Food consumption	54	51	45	42	30
Public transfer	15	5	4	3	1						
Private transfer	14	5	4	3	2						
Loan	10	10	10	8	10						
Dis-saving	1	1	1	1	1	Saving	5	5	7	8	11
Productive asset depletion	1	1	2	1	2	Productive asset investment	1	1	1	2	3
Consumable asset depletion	7	6	5	4	3	Consumable asset investment	7	9	7	7	5
Other income	1	1	1	1	1						
Other transfer	9	6	3	5	4	Other expense	33	34	40	41	51
<i>Total</i>	100	100	100	100	100		100	100	100	100	100

In terms of expenditure, food consumption accounts for more than 50% of the total budget for the 1st and 2nd quantiles. Compared to the component of labour income in the total budget, it can be seen that households in the lowest quantile fail to cover their food expenditure costs and rely on external transfers. As incomes increase from the 1st to the 5th quantile, in accordance with Engel's Law, food consumption as a proportion of the total

budget consistently reduces from 54% to 30%. Despite the low incomes, the propensity to save is significant. While dis-saving accounts for only 1% of the total budget, savings account for the minimum 5% of the budget and the propensity to save increases as total income increases to 11% of total expenditure for the 5th quantile. Although investments in assets are small, we notice a marked difference in asset accumulating behaviour. Higher income households tend to invest more in productive and consumable assets. For poor households in the lowest quantile, the depletion rate of assets is equal to the investment rate at 1% for productive assets, and 7% for consumable assets. These households consider assets as a strategy to smooth budget. While other income and transfers account for small percentages of total budget, other expenses are substantial, especially for richer households, at almost 50%.

Figure 3.3 compares the distribution of incomes and budgets of seven regions in the order of increasing per capita income. As can be seen, the budget for the poorest region of North West is quite similar to the income distribution. Labour income is the sole driver of the budget, and households in this region do not have assets, savings or access to credits and transfers to make up for any income shortfalls. When we consider Central South, Central North and North East, the changes in labour income distributions are not substantial, but the budget distributions significantly shift to the right and become flatter. This implies that these regions have better coping and risk-sharing capacity in terms of assets ownership and receipt of transfers and credits. For the three remaining regions, the labour income distributions are closer to the budget distributions. However, both income and budget distributions are flatter and of higher values than those of North West. Red River Delta has a bigger gap between income and budget distribution than Central Highland and Mekong

Delta. The shapes of the distribution are also flatter, which suggests a more equal distribution of welfare in the region.



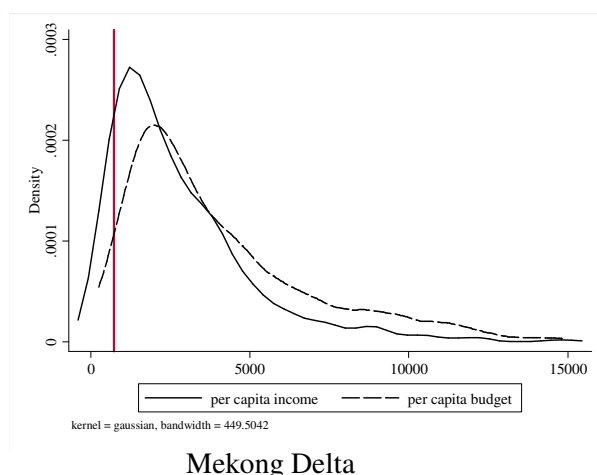


Figure 3.3: Regional distribution of income and budget
The red line signifies the poverty line of 2\$/day

3.5.2 Income and Food Consumption

In this section, we examine the heterogeneity of the largest component in the budget: income and food consumption. Figure 3.4 compares the per capita income of seven regions using data of four survey rounds. The left figure presents the density distribution and the right presents the cumulative distribution. As can be seen, 50% of North West population has income under the poverty line. That proportion is significantly reduced in the following order: Centre South, Centre North, North East, Red River Delta, Central Highland and Mekong Delta. For three most developed regions of Red River Delta, Central Highland and Mekong Delta, not only are the proportions of households under the poverty line smaller, but their labour incomes are also higher.

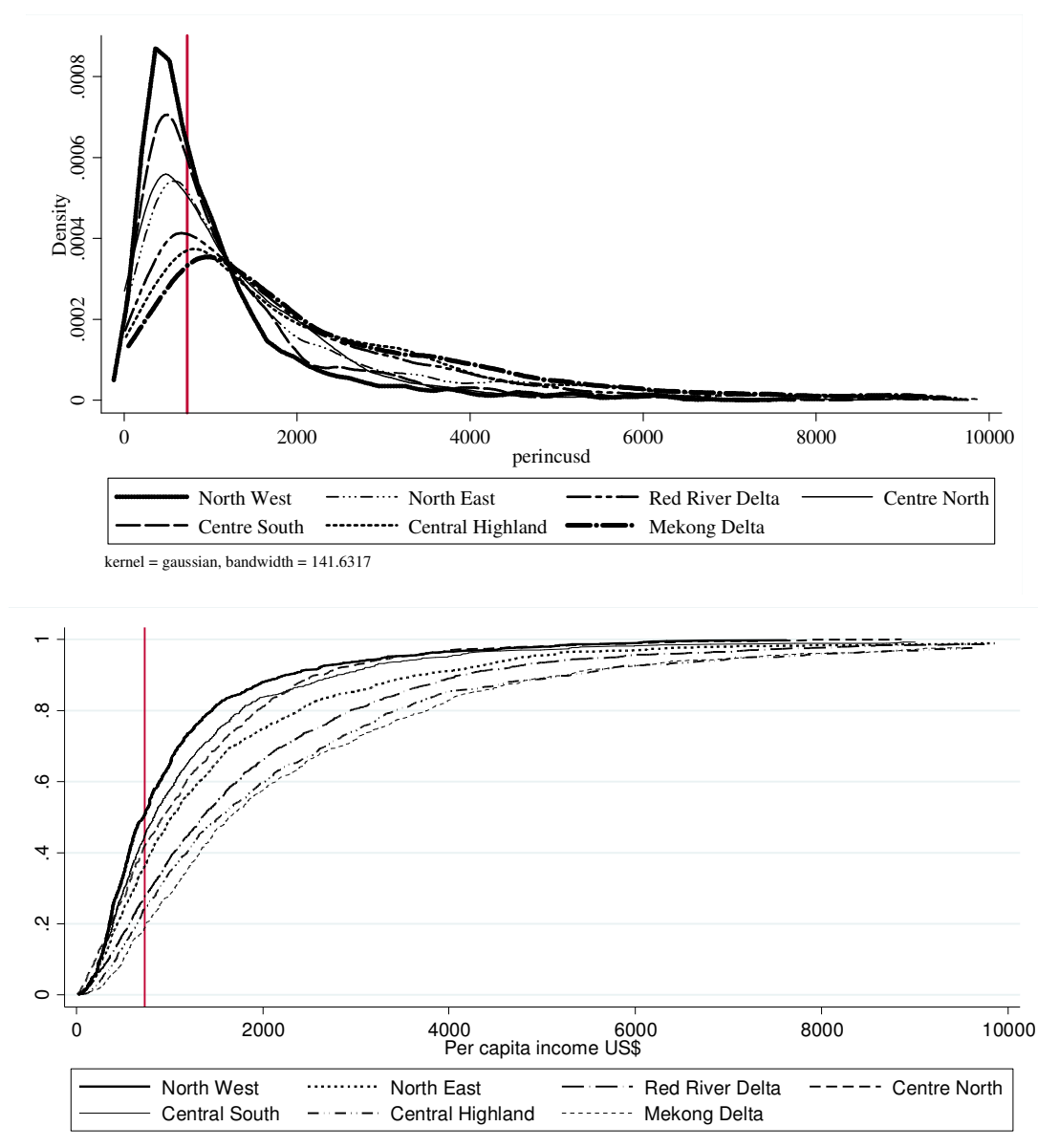


Figure 3.4: Regional distribution of income

The red line signifies the poverty line of 2\$/day

Comparison of the evolution of income and food consumption over time shows that there are distinct gaps among the regions (Figure 3.5). North West, Centre South and Centre North form the low-income group, with North West being the lowest. Red River Delta, Central Highland and Mekong Delta form the high-income group, with Mekong Delta the highest. North East is the middle-income region. Although three groups display rapid increases in income over the years, the income growth for the high-income group is much

higher than the low-income group. Food consumption is shown to closely track income. It similarly shows a rapid increase over time, and reflects the income ordering, with North West being the lowest and Mekong Delta being the highest. However, the gaps in evolution of food consumption are not as distinct as those of income distribution. Except for North West, which falls much below other regions in terms of food consumption levels, the differences in food consumption levels are very small. Some extent of consumption smoothing is achieved in the sample (Campbell & Deaton, 1989).

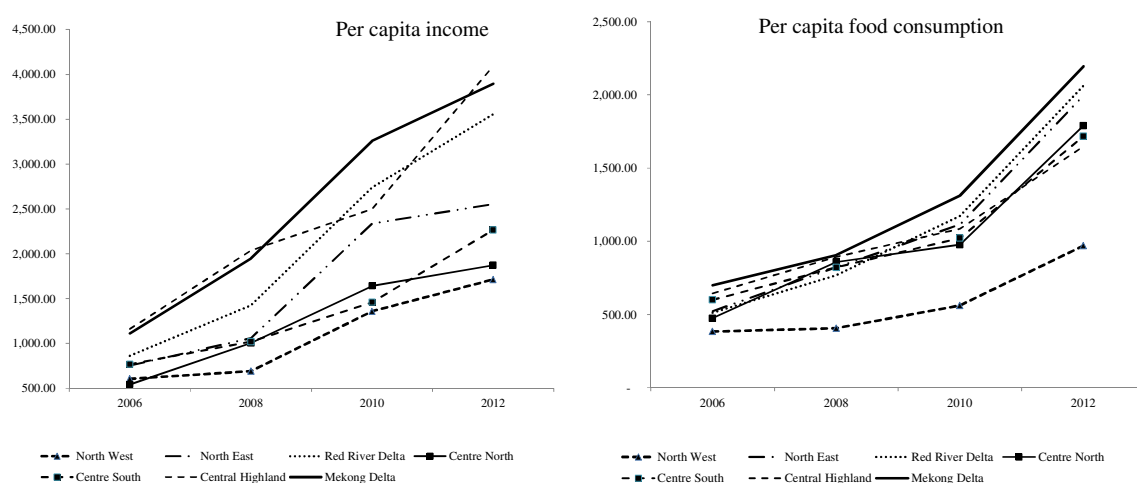


Figure 3.5: Temporal evolution of income and food consumption

3.5.3 Assets Heterogeneity

Table 3.5 shows the regional differences in ownership of assets. We divide the assets into three groups: *productive assets* are those used in production, such as grinding machine, harvesting machines, cars and boats; *vehicles* refer to bicycles and motorbikes; *consumable assets* refer to household items such as fridges, TV, radios etc. In general, ownership of assets strongly mirrors the regional income distribution: regions with high incomes tend to have more assets, and the values tend to increase over time. Vehicles and consumable assets are more common than productive assets, and almost all households in the sample

have agricultural land. The year 2008 is generally associated with a significant decrease in asset values, which might be the effect of the Global Financial Crisis.

Table 3.5: Characteristics of assets

	Percentage with assets (%)				Average amount (mil VND)			
<i>Productive assets</i>	2006	2008	2010	2012	2006	2008	2010	2012
North West	36	36	54	44	10.33	0.97	12.28	8.71
North East	59	32	43	48	3.87	7.93	13.41	14.68
Red River Delta	41	38	29	22	9.70	7.90	23.69	19.34
Centre North	56	55	48	34	6.64	4.53	7.13	15.44
Centre South	32	46	49	23	29.62	13.57	11.79	59.12
Central Highland	68	69	61	60	8.29	8.78	13.38	21.34
Mekong Delta	60	51	61	51	22.74	226.49	53.89	4.90
<i>Vehicles</i>	Percentage with assets (%)				Average amount (mil VND)			
North West	62	64	76	79	7.66	6.70	9.68	11.54
North East	96	93	95	93	7.64	6.89	8.25	9.15
Red River Delta	93	94	95	93	8.81	6.48	9.56	13.95
Centre North	90	93	87	93	7.11	5.93	6.53	9.35
Centre South	85	92	90	89	7.74	4.45	9.19	14.14
Central Highland	90	92	94	92	10.00	7.06	9.57	13.80
Mekong Delta	86	90	91	95	8.21	6.00	9.01	10.11
<i>Consumable assets</i>	Percentage with assets (%)				Average amount (mil VND)			
North West	71	82	83	96	2.91	2.16	2.96	4.10
North East	94	96	97	99	3.77	3.38	5.08	4.84
Red River Delta	94	97	99	98	4.37	3.38	5.42	8.84
Centre North	91	94	96	97	3.44	2.63	3.53	4.53
Centre South	82	91	93	96	3.43	2.02	3.65	5.02
Central Highland	94	96	97	98	4.34	3.33	4.08	6.23
Mekong Delta	92	98	96	96	4.48	2.72	4.49	4.50
<i>Agricultural land</i>	Percentage with assets (%)				Average area (hectare)			
North West	98	98	99	99	1.67	1.07	1.03	0.96
North East	96	97	97	98	0.43	0.38	0.42	0.35
Red River Delta	97	98	98	98	0.25	0.24	0.22	0.23
Centre North	84	86	87	88	0.78	0.75	0.69	0.71
Centre South	93	93	93	93	0.77	0.40	0.32	0.36
Central Highland	90	94	94	95	1.57	1.49	1.46	1.49
Mekong Delta	87	90	91	91	1.78	1.63	1.62	1.59

Even though all households in the sample are in rural areas and thus highly reliant on agriculture, not all households have productive assets. Central Highland and Mekong Delta

have the highest proportions of household with productive assets ownership, at about 60%. Central South have the lowest proportion of productive assets ownership. North West started as the region with the lowest productive assets ownership rate, but gradually increased to approximately 50%. Red River Delta and Centre North, on the contrary, started with approximately 50% rate and ended with only 20% to 30% households having productive assets. Central South and Mekong Delta are the regions with the highest average values of productive assets, which are mainly due to ownership of boats. However, households in Mekong Delta depleted substantial high-value productive assets in 2012 and became the region with the lowest average asset value. The North West started among the regions with high values of productive assets but ended up the second lowest value of productive assets.

Ownership of motorbikes and bicycles is very common in Vietnam. North West is the region with the lowest proportion in ownership of vehicles, but the ownership rates have increased from 2006 at 62% to 2012 at 79%. Other regions have 90% to 95% population in ownership of vehicle assets. The average values of vehicles differ little across the seven regions, and tend to increase across time.

Similar to vehicles, nearly all households in our sample own consumable assets. The values of these assets differ slightly across the regions. Red River Delta appears to have relatively higher values of consumable assets than other regions, especially in 2012, which possibly is due to their proximity to the urban hub of Hanoi. Over time more and more households own consumable assets. This is a good sign for the sample as more consumable assets mean more comfortability for the family.

The prevalence of agriculture among rural households in Vietnam is evidenced through the ownership of agricultural land. Almost all households in the sample own agricultural lands.

Centre North has the lowest ownership rates of 88%. Land areas are distributed unequally from North to South. North West, Central Highland and particularly Mekong Delta have the largest agricultural land areas, from 1 to 1.6 hectares. Red River Delta has the smallest average agricultural land area of only 0.2 hectare. Centre North have larger land areas of 0.7 hectare and two remain regions have only 0.4 hectare of agricultural land areas. As can be seen, the farm size of the sample is representative of the small scale of production in Vietnam.

3.6 Household Livelihood Strategies

3.6.1 Characteristics of household labour force

Figure 3.6 shows marked differences in labour characteristics among the seven regions. North West has the lowest average education levels but has the largest family size. On the contrary, North East has the highest average education levels but has the smallest family size. Mekong Delta's average education level is the second lowest, but the levels are substantially higher than North West, with the average household head having two years of schooling more than the North West. Central South and Central Highland are quite similar in terms of education levels. Together with North East, Red River Delta and Centre North are the three regions with the highest education levels. Even though the household sizes tend to reduce over time, North West and Central Highland still have the highest numbers of household members. Together with North East, Mekong Delta and Central South are the regions with the smallest numbers of household members.

The structures of the household also differ across regions. As the sampled households get older, proportions of children decrease and proportions of adults in the labour age increase. Mekong Delta has the largest proportion of labour force and smallest proportion of children. North West has the largest proportion of small children, but apparently many

children have grown up during the survey rounds and have significantly increased the labour force of this region to the similar height of Mekong Delta. Red River Delta and North East have quite similar proportions of labour aged members, whereas Central South has the lowest proportions of labour force. Except for North West, the proportions of children are quite small and similar across all regions. Red River Delta started with quite a large proportion of children but that has reduced significantly to the same low with other regions.

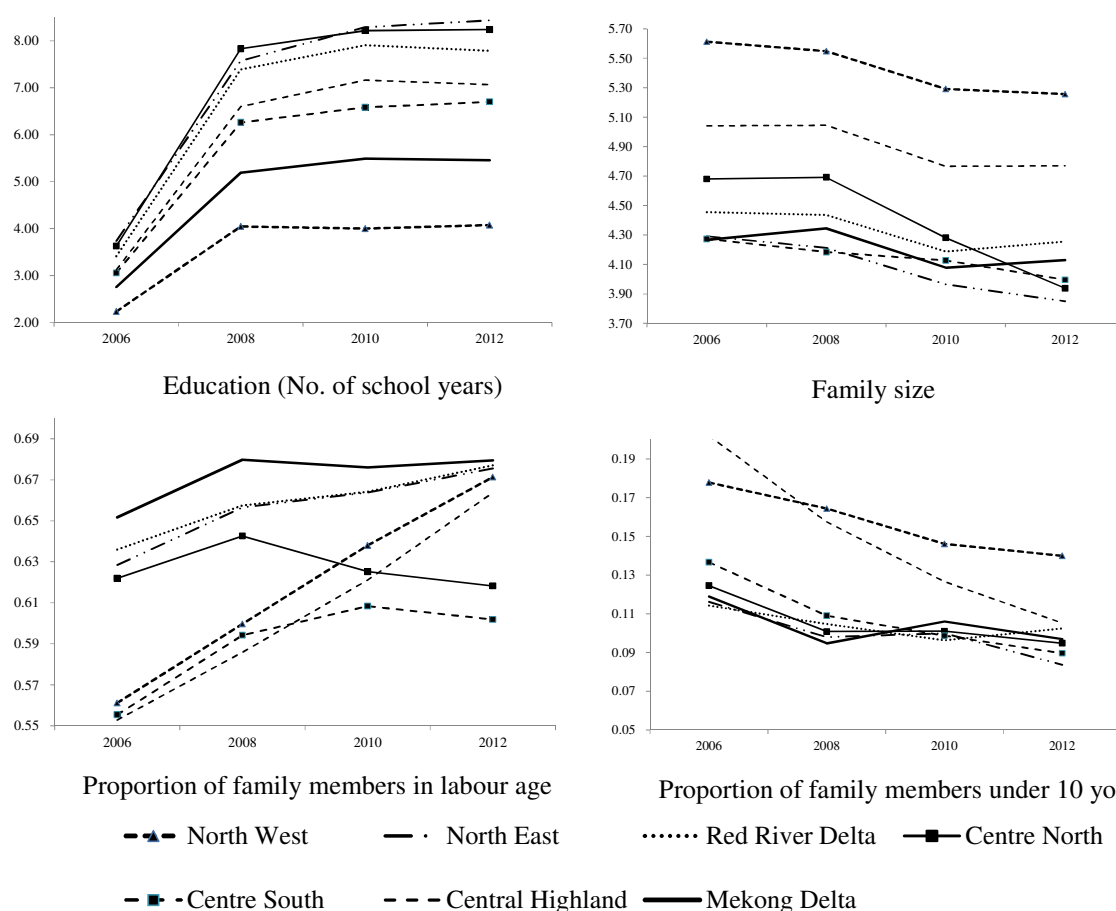


Figure 3.6: Changes in labour characteristics through time

3.6.2 Labour Allocation Strategies

Although the majority of the rural labour force is in agriculture, a larger proportion of farmers participate in off-farm diversification activities. As agricultural production grows,

the rural non-farm economy has flourished and diversified, especially in processing of agricultural products, rural trade and services. The presence of *pluri-active* agricultural households has been noted by several authors (Barrett, Reardon, & Webb, 2001; Buchenrieder, 2005; Fuller, 1990; Reardon et al. 2007). These households engage in different non-farm activities for different reasons, to raise socio-economic status, to support consumption when revenue from agriculture is not sufficient, but still rely on agriculture as their main income generating activity. Figure 3.7 shows the prevalence of pluri-active households in rural Vietnam. Only 20% of the rural households rely on agriculture as their *only* source of income, and approximately 70% combine agriculture with either waged activities or business activities. The proportion of households without reliance on agriculture is very small, but increases gradually from 10% in 2006 to approximately 20% in 2012. This increase is mainly due to the proportion of households that derive their income from waged activities only.

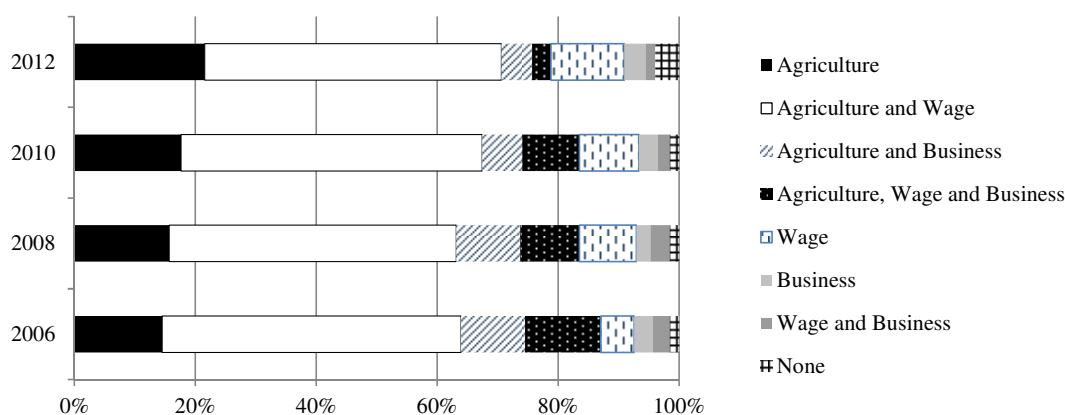


Figure 3.7: Temporal changes in agriculture and non-farm diversification

In the following section, we analyse in detail each activity and evaluate the regional and temporal differences.

3.6.2.1 Agricultural Activities

Agriculture remains the livelihood strategy of the sampled households (Table 3.6). However, the allocation of total labour days to agriculture is not similar across the seven regions. North West has the largest allocation of labour days to agriculture, at approximately 80%, while Red River Delta, Centre South and Mekong Delta are three regions with the smallest allocation of labour days to agriculture, at about 40%. Central Highland ranks second, after North West in terms of labour allocation days, at about 65%, while North East and Centre North at about 60%. In general, there is a slight decrease in the proportion of labour days allocated to agriculture over time.

Table 3.6: Labour allocation to agricultural activities (%)

	2006	2008	2010	2012
North West	75	83	78	74
North East	58	61	53	50
Red River Delta	43	41	39	34
Centre North	62	55	50	57
Centre South	45	44	54	39
Central Highland	65	66	62	59
Mekong Delta	45	40	39	41

Table 3.7 summarises the characteristics of livestock and crops in agricultural activities in seven regions over time. North West has the highest proportions of households raising livestock, mainly buffalos, pigs and poultry, which range from 65% to 85%. Cows are rare in this region, and only 10% of the households raise them. Cows are more common in regions other than North West. Centre North has the highest proportion of cow owners, at 40% in 2006 but that number has gradually decreased to 26% in 2012.

Table 3.7: Characteristics of agricultural activities

North West		Percentage of the households (%)				No. of animals per household			
Livestock	2006	2008	2010	2012	2006	2008	2010	2012	
Cows	9	7	4	8	4	3	1367	3	
Buffalos	73	68	71	64	2	2	2	2	
Pig	74	78	83	78	4	13	8	4	
Poultry	89	81	86	84	25	22	25	20	
Crops	Average total output per household (tonnes)								
Rice	95	6	91	91	2.19	0.90	1.99	2.01	
Maize	72	23	68	72	1.48	0.69	1.05	1.06	
Potato	58	18	38	38	1.33	1.37	1.76	1.65	
North East		Percentage of the households (%)				No. of animals per household			
Livestock	2006	2008	2010	2012	2006	2008	2010	2012	
Cows	31	28	20	12	2	2	2	1	
Buffalos	29	28	24	15	2	1	1	1	
Pig	59	49	46	39	5	6	8	6	
Poultry	85	69	81	64	36	36	33	26	
Crops	Average total ouput per household (tonnes)								
Rice	92	0	82	80	1.35	0.46	1.40	1.32	
Maize	52	14	43	32	0.42	0.26	0.52	0.74	
Potato	37	5	22	16	0.48	0.70	0.60	1.82	
Tea	17	14	15	7	1.40	1.75	1.78	2.31	
Red River Delta		Percentage of the households (%)				No. of animals per household			
Livestock	2006	2008	2010	2012	2006	2008	2010	2012	
Cows	19	16	11	8	2	2	1	1	
Buffalos	4	3	3	2	1	1	1	1	
Pig	49	33	27	20	5	7	8	9	
Poultry	43	44	40	39	47	53	53	59	
Crops	Average total output per household (tonnes)								
Rice	88	1	82	76	1.67	1.31	1.78	1.77	
Maize	12	5	11	9	0.31	0.42	0.37	0.59	
Potato	13	5	10	7	1.09	1.02	0.81	0.84	
Centre North		Percentage of the households (%)				No. of animals per household			
Livestock	2006	2008	2010	2012	2006	2008	2010	2012	
Cows	40	32	30	26	2	2	224	2	
Buffalos	28	30	26	22	2	2	2	1	
Pig	59	49	40	38	3	4	4	3	
Poultry	80	71	77	74	21	25	27	25	
Crop	Average total output per household (tonnes)								
Rice	75	2	69	70	1.79	1.19	1.51	1.70	
Maize	46	9	39	28	0.45	0.27	0.33	0.34	
Potato	39	17	18	10	0.75	1.08	0.93	0.68	
Tea	6	2	7	5	0.26	0.59	0.22	0.96	
Sugar cane	9	7	7	6	16.01	24.15	9.76	14.05	
Centre South		Percentage of the households(%)				No. of animal per households			
Livestock	2006	2008	2010	2012	2006	2008	2010	2012	
Cows	28	26	22	16	2	2	2	2	
Buffalos	15	16	13	13	1	2	2	1	
Pig	59	48	47	34	4	4	6	2	
Poultry	60	48	56	35	15	25	19	23	
Crop	Average total output per household (tonnes)								
Rice	83	9	81	77	1.70	0.57	1.69	1.88	
Maize	18	9	17	13	0.73	0.42	0.68	0.91	
Potato	23	17	21	11	0.80	1.21	1.52	1.35	
Central Highland		Percentage of the households(%)				No. of animal per households			
Livestock	2006	2008	2010	2012	2006	2008	2010	2012	
Cows	23	12	11	9	3	3	2	2	
Buffalos	8	5	5	4	2	2	2	3	
Pig	32	26	25	23	6	6	8	8	
Poultry	55	57	55	55	24	37	30	33	
Crop	Average total output per household (tonnes)								
Rice	44	9	41	41	3.00	1.72	3.11	4.39	
Maize	35	23	28	22	2.53	2.81	2.68	3.72	
Potato	11	9	8	8	4.87	2.98	2.79	4.14	
Tea	4	5	3	3	3.75	3.63	1.84	2.31	
Coffee	59	54	60	63	2.00	2.73	3.87	3.75	
Cashew	12	14	14	14	0.68	0.42	0.84	0.84	
Pepper	12	12	7	9	0.50	0.38	0.78	0.72	
Mekong Delta		Percentage of the households(%)				No. of animal per households			
Livestock	2006	2008	2010	2012	2006	2008	2010	2012	
Cows	15	12	12	8	3	4	197	6	
Pig	22	11	14	9	12	15	21	20	
Poultry	48	38	45	30	37	115	138	213	
Crop	Average total output per household (tonnes)								
Rice	69	28	62	64	12.37	11.31	16.37	19.71	
Sugar cane	1	1	2	0	65.00	165.97	99.67	401.00	

In the beginning, North East, Central South and Central Highland each had about 30% cow raisers, whereas Red River Delta and Mekong Delta each had only 15% to 19% of households keeping cows. These regions similarly experienced a gradual reduction of 10% to 15% in the proportions of households with cows from 2006 to 2012. On the other hand, buffaloes are much less common in regions other than North West. Red River Delta and Central Highland had less than 5% of households keeping buffalos and Mekong Delta had almost no buffalos. In other regions, approximately 20% of the households raise buffalos. In Vietnamese culture, buffalos and cows are traditionally used for ploughing rather than for meat. In recent years, with the presence of ploughs and other farm machines, the use has become less common.

Poultry is the most common type of livestock kept in rural Vietnam. Approximately 80% of households in North East and Central North raise poultry. In other regions, that number ranges from 40% to 60%. However, from 2006 to 2012 a general reduction of 5% to 10% in the proportion of poultry growers is noted in most regions. North West and Central Highland are two exceptions with the proportions consistently at 85% and 55% respectively.

Pigs are the second most common livestock in rural Vietnam. In general 60% of the households keep pigs. Central Highland and Mekong Delta are the two exceptions with only 30% and 20% of the households keeping pigs respectively. However, these proportions have also decreased by approximately 10%. The reductions are largest for North East and Central South regions.

In general, the livestock scales are very small. Each household tends to have a few cows and buffaloes and less than 10 pigs. The number of poultry animals also approximates 30 animals only. In the north, Red River Delta has the largest scale of poultry, of around 50

animals per household. In the south, Mekong Delta has the largest scale of pigs per household, from 12 to 20 animals, and poultry, from 40 to even 200 animals. Although this region has the smallest proportion of livestock growers, Mekong Delta has the largest size of livestock in all seven regions.

As can be seen, rice is the main crop that is grown in all regions from North to South. The proportions of households that grow rice range from 80% to 90% and North West is the region with the highest proportion. Mekong Delta and Central Highland are the two exceptions, with only 65% and 40% respectively of the households growing rice. Notably, rice is the only crop in Mekong Delta. Other crops are grown by small numbers of households in this region.

Because there are only two main rice growing seasons in Vietnam (spring season from January to April and summer season from May to August), farmers also grow maize and potatoes between rice crops. Maize is mainly grown in the north, especially in North East by about 70% of the households. In the 2006, 50% of the sampled households in North West and Central North grew maize but the proportion decreased over the next periods to 30% in 2012. Similarly, 30% of Central Highland households were maize growers in 2006 but that number has gradually decreased to 22% in 2012. Similar to maize, potatoes are mainly grown in the north. However, the proportions have decreased from 58% to 38% in North West and from 37% to 16% in North East. In other regions, the proportions have decreased to approximately 10%. Apart from the three crops, other regions have diversified into high-value crops. Examples are tea in North East and Central North, and sugar cane in North East. However, the proportions of the growers are small and on the decrease. Central Highland particularly has a large variety of crops. In addition to rice, coffee is also the main

crop of this region with 60% of the households being coffee growers. In addition to maize and potatoes, about 5% grow tea, 10% to 14% grow cashew and peppers.

The total crop yields for North West are relatively high in the sample. However, these yields are not much higher than in other regions where the proportions of crop growers are much lower. Given the advantage of river sediments, Red River Delta has the second highest total crop outputs in the north and Mekong River Delta has the highest total crop yields in the south. Central Highland which has the largest variety of crops is among the regions with the largest proportion of crop growers and also among the regions with highest yields in the sample.

Figure 3.8 plots the total output of rice - the staple crop - among seven regions from 2006-2008. Even though Mekong Delta has the lowest percentage of rice growers, the total outputs in this region are about 10 times larger than other region. This reflects the large scale and high productivity of agriculture in this region. Comparison of regional total rice outputs with Mekong Delta exclusion shows that Central Highland with similar advantages of Mekong Delta has the highest total outputs among the remaining regions. This high output is again in consideration of the lowest percentage of rice growers and large extent of diversification into non-rice crops, which again highlights the productivity of this region. North West ranks next in terms of total outputs. Central South and North East have the lowest total rice outputs whereas Red River Delta and Centre North belong to the middle group.

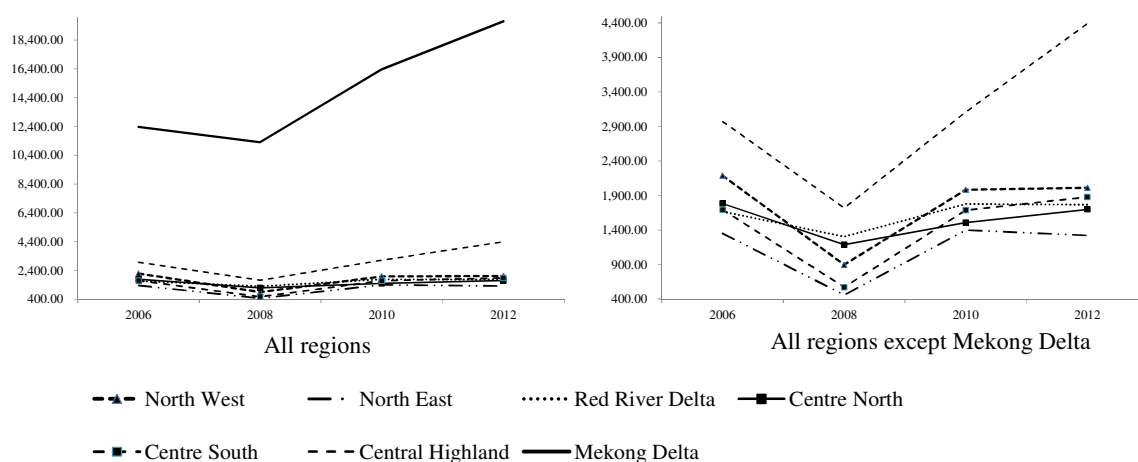


Figure 3.8: Comparison of regional total rice output over time

The year 2008 is associated with a drop in total outputs and agricultural activities of all regions. Not only are the total outputs reduced but so are the percentages of growers. One possible reason is the effect of the GFC that led to an inflated input price and stagnant activities in the market.

3.6.2.2 Non-farm Activities

Diversification into non-farm activities potentially brings higher incomes for rural households (De Janvry & Sadoulet, 2001; Rigg, 2006). However, the nature of non-farm activities in the rural sample tends to be of low skills and low returns. The most common waged activities are builders and casual farm work. The business activities tend to be of small scale, such as food vendors. We impute monthly salary of our sampled households by converting their daily wages into monthly wages by multiplication of 30. For the few observations who gave wage rates in hours we assume that they work 24 hours per day and 30 days per month. Despite this strong assumption, table 7 shows that the average monthly salary in the sample is very low and shows limited improvement over time. Table 7 shows that the average monthly salary in the sample is very low and shows limited improvement over time. Interesting, the monthly rates are quite similar across all seven regions, which

approximate 3 mil VND per month or 150 US\$/month. Red River Delta, Central Highland and Mekong Delta are three regions with relatively higher wage rates than other regions.

Table 3.8: Monthly average salary of waged activities (mil VND)

	2008	2010	2012
North West	1.52	2.02	3.15
North East	2.72	2.35	3.16
Red River Delta	2.17	2.86	3.64
Centre North	2.03	2.18	3.29
Centre South	2.48	2.47	3.18
Central Highland	2.46	3.54	3.60
Mekong Delta	1.98	4.03	3.68

Figure 3.9 compares the average allocation of labour days to non-farm activities. As can be seen, wage earning is the dominant non-farm activities, compared to small business activities. Mekong Delta has the highest participation rate in waged activities, at 40% to 45% and the third highest rate in business activities, at 10% to 15%. Red River Delta has the highest participation rate in business activities, at 20% to 28% and has the second highest rate for waged activities participation, at 26% to 40%. This active involvement in non-farm diversification can be explained by the strategic locations of both regions with two central economic hubs of Vietnam – the capital Hanoi in the North and Ho Chi Minh city in the South. In both non-farm activities, North West ranks the lowest and the difference in labour allocation compared to the most diversified region is starkly serious. Approximately 15% of North West households participate in waged activities and only 5% in business activities. Surprisingly, Centre South has a very high participation rate in non-farm activities. It ranks second in terms of participation rate in business activities (15%) and in some years have higher rates than Red River Delta in waged activities (30%-40%). Central Highland has the second lowest rates in non-farm diversification, which possibly is due to their high participation in agricultural activities.

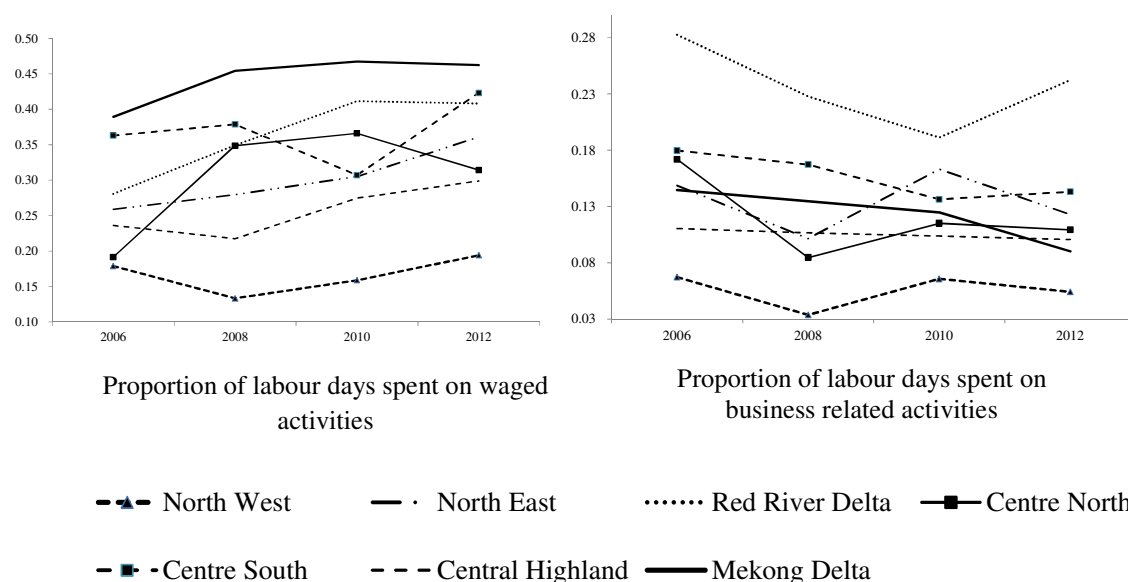


Figure 3.9: Regional allocation of non-farm labour activities over time

3.7 Role of Financial Markets

The financial markets in rural regions include both formal and informal savings and credits. Formal savings and credits refer to the deposits and loans made to financial institutions in rural Vietnam. Agricultural Bank (AgriBank) and Vietnam Bank for Social Policies (VBSP) are the two main banks present in rural Vietnam. Other than these two banks, People Credit Organization is of smaller scale but is the most common financial institution in rural Vietnam. Informal savings and credits refer to ROSCAs and loans made formally among relatives, friends or moneylenders. While savings are monetary, credits can include in-kind such as advances for fertilisers from suppliers. In the following analysis, the penetration rates are the percentages of households in the region with positive balances of savings or credits. The scales refer to the average amounts of these financial balances.

As can be seen from Figure 3.10, both formal and informal saving penetration rates and scales tend to increase over time for the seven regions. Starting with the lowest formal saving penetration rate of only 1%, Mekong Delta has consistently increased this rate to

16% and is among the regions with the highest saving penetration rates. This region is also characterised by the largest amounts of formal savings. Other regions with high formal saving rates are North East, Central Highlands and Central North. However, except for Central Highland with comparatively high average savings, Central North and Central East are the two regions with the lowest average savings. In the beginning Central South had the highest formal saving penetration rate but the rate has reduced over the period to the second lowest rate. However, the average amount of savings of this region has consistently increased to the highest level of the seven regions. North West has the lowest penetration rate of 1% and the lowest average amount of savings.

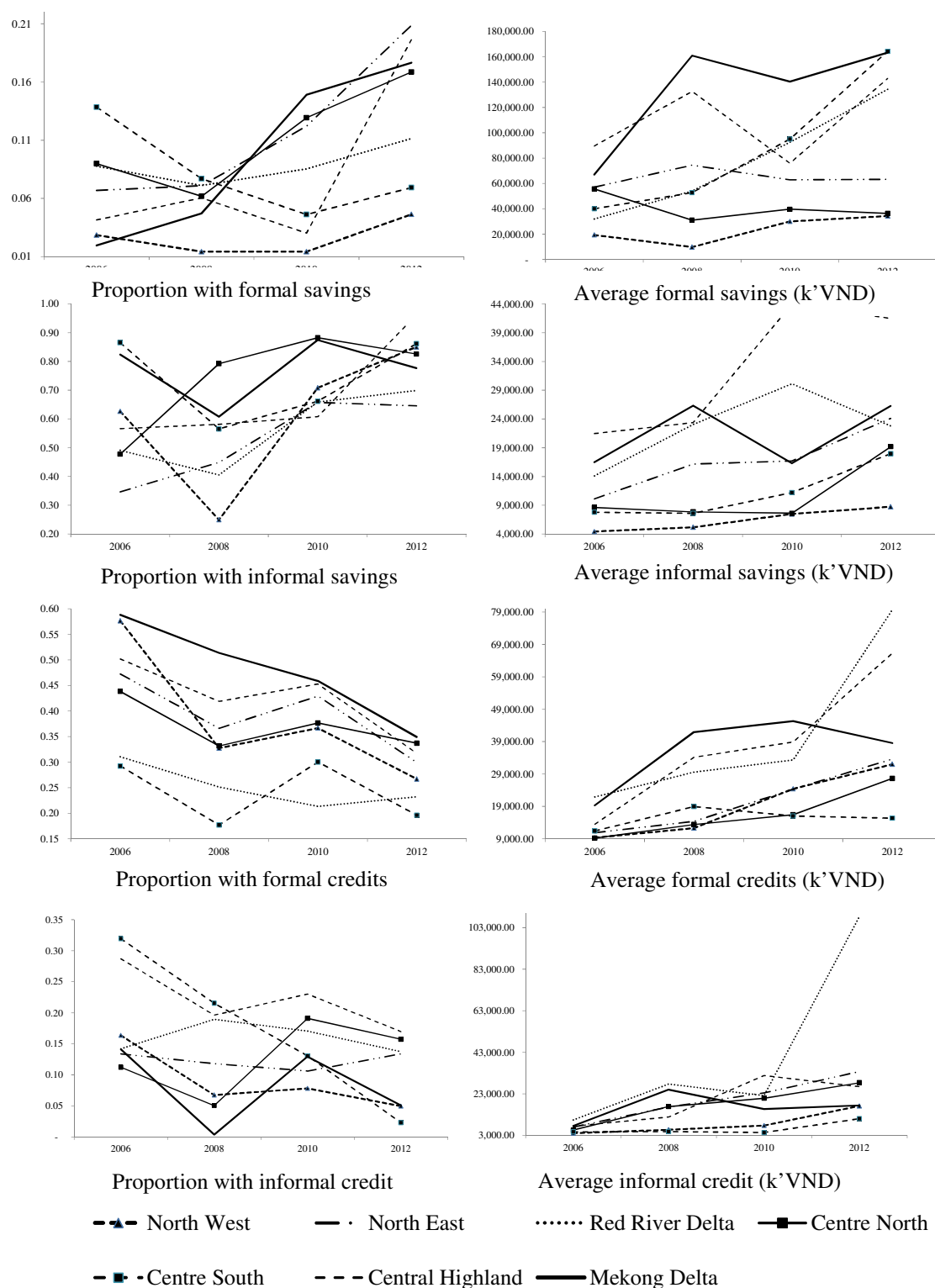


Figure 3.10: Financial markets penetration and scale

Compared to formal savings, the amounts of informal savings are smaller but the penetration rates are higher. The minimum penetration rate for informal saving is 20% and

that was in North West in 2008. By comparison, 20% is the highest penetration rate for formal saving and that was in North East in 2012. However, the scale of informal savings is much smaller than formal savings. The largest average amount of informal saving approximates 40 mil VND, which is a quarter of the largest amount of formal saving. The dominant role played by informal financial sector in rural areas has been noted in the literature (Tsai, 2004). Regrettably, this role is undermined by the small scale of the saving amounts. Mekong Delta, Red River Delta and Central Highland continue to display high penetration rates of approximately 80% and the average saving amounts are comparatively higher. Although the informal savings penetration rates for Central North and Central South are similar, the average savings are much smaller. North West's informal saving rate was severely affected in 2008 but gradually recovered and increased to 80% in 2012. However, similar to formal savings, the average amount of informal saving in this region is consistently the lowest.

In contrast with savings, the credit penetration rate has consistently decreased. The decrease is less severe for Mekong Delta and Central Highland, from 50% (Central Highland) and 60% (Mekong Delta) to approximately 40%. However, in Mekong Delta the amount of formal credit fluctuates wildly around the level of 30 mil VND. In Central Highland, this amount has consistently increased to 65 mil VND. Red River Delta closely tracks this trend of Central Highland with an average amount formally borrowed on the increase from 20 mil VND to the highest level of 80 mil VND. This region nevertheless has low penetration rates for formal credits, at 30%, which is similar to South Centre. In the beginning, North West was among the regions with the highest access to formal credits (60%), but ended among the regions with the lowest penetration rate (30%). As can be seen, Red River Delta, Mekong Delta and Central Highland distinctively have higher average amounts of formal

credits. The difference in the average formal credits of these regions compared to the other regions is as substantial as 15 mil VND.

In contrast with formal credits, Mekong Delta has the lowest penetration rate for informal credits of only 10%. The amount of average informal credits in this region is also smaller, at 10 mil VND. Central Highland and Red River Delta continue to have higher penetration rates and higher average informal loans than the other regions, at approximately 25% and 25 mil VND. The decrease in penetration rate is the most severe for Centre South, with the starting proportion of households with informal credits was at 30% in 2006 and only 5% in 2012. North West consistently had low penetration rates of informal credit and smallest balances of informal loans. For regions other than Centre South and North West, the amounts of informal loans tend to increase, especially for Red River Delta. The average amount of informal loans in this region was even higher than formal loans in 2012. The penetration rates for informal credits are smaller than formal credits but the scales of the two sectors are quite similar.

3.8 Role of Safety Nets

For rural households, two important sources of transfers are public and private. Public transfers refer to government social security programs and non-governmental support. Most of these transfers are pensions, supports for health care, education and poverty alleviation. Private transfers refer to remittances that the households receive from family members, relatives and friends. These transfers are gross amounts received by the rural samples as no data are available on the transfers made by these households.

Figure 3.11 shows that North West has the highest percentage of households in receipt of public transfers, and that percentage tends to increase over time from 55% to 70%. South Centre ranks next with a special hike in the receiving rate of 70% in 2008, but the trend

decreases over the next two survey waves to only 45%. Centre North, North East and Red River Delta are three regions with continuous increases in the percentages of receiving public transfers from 15%, 22%, 32% to 30%, 40% and 60% respectively. However, Red River Delta and Mekong Delta are the two regions with the lowest percentages of public transfers receipt. In contrast with the receiving rates, the average amounts of received public transfers are the highest for North East, Red River Delta and Centre North, and the lowest for North West. There appears to be a trade-off between the coverage of the public transfers and the average amounts actually received by each rural household.

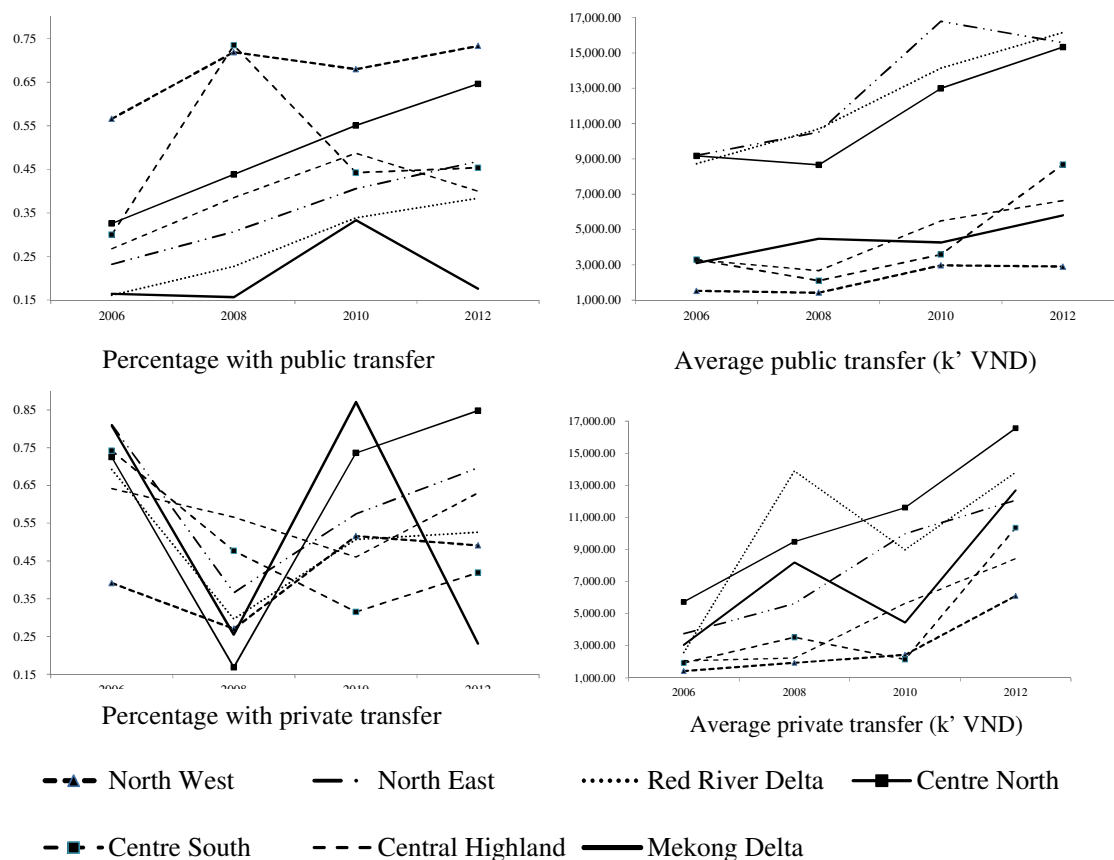


Figure 3.11: Roles of public and private transfers

The pattern for private transfers is less stable. Centre North and Mekong Delta are the most unstable with as high as 80% and as low as 15% of the households in receipt of private transfers. For the more stable regions of Central Highland and Central South, the trend is a

general decrease to 65% for Central Highland and 40% for Central South. The trend for North West and Red River Delta is a general increase to approximately 55%. The amounts received from private transfers are highest for Centre North, Red River Delta and North East, at about 11-15 mil VND. The average private transfers for Central Highland and Central South are the lowest, at about 7-9 mil VND. North West has the lowest average amount of private transfers, at only 5 mil VND.

3.9 Conclusion

An analysis of regional heterogeneity in welfare, livelihood, financial market and safety networks of rural households in Vietnam reveals many issues in rural areas of developing countries. First, we notice that similar to other rural areas in developing countries, rural Vietnam is experiencing a transition in livelihood strategies from sole reliance on agriculture to *pluri-active* agriculture. Households in rural areas still spend the majority of their labour days on agriculture. However, they tend to diversify their activities with time. The diversification tends to happen outside the farms rather than on farms, as the variety of crops and livestock has decreased as households decrease allocation to agricultural activities. Increasingly they are engaging in non-farm activities, which are mostly casual waged labour workers such as builders and hired farm labour workers. These diversification strategies have proved highly effective for households in response to shortfalls in agricultural income in order to stabilise and improve their livelihood (Meert et al., 2005). The problem with these strategies is the low-skill nature of these non-farm activities, and thus low wage rates. Therefore, they do not offer desirable security for these farmers.

Secondly, agriculture in rural Vietnam suffers from fragmented land size and thus fails to achieve large production scales. Mekong Delta is distinct from the other six regions with

total rice produce ten times as much, but their scale of household production is still small by the world standard, with only 1.6 hectare of agricultural land on average. The small scale of production on one hand allows high flexibility for Vietnamese farmers to respond to high-risk agricultural environment, especially the high exposure to natural disasters. On the other hand, the inefficiency brings many challenges for these households to scale up their agricultural investment and returns. Although the rudimentary agricultural practices, for example using livestock in cultivation, have decreased, the ownership of valuable productive assets is still not common, except for the ownership of basic vehicles such as motorbikes and bicycles. North West, the region where agriculture is most important, is also the region where these problems are most serious.

The third problem is the endogeneity of financial market development and private transfers. Credit markets, which are considered an important instrument to boost agriculture productivity and break the vicious circle of low investment in poor farmers, are dependent on the general welfare status of the households themselves. In the regions where households actively engage in high productive agriculture and non-farm activities, credit markets are more active with more borrowers and larger amounts of loans made, and vice versa. There seems to be an asymmetry in formal and informal saving and credits. A majority of rural households use informal savings, compared to formal savings, but the average amounts of informal savings are much smaller than formal savings. More rural households use formal credits than informal credits, and the scales of the two credit sectors are comparable. While savings are on the increase, credits seem to decrease in the last decade. Therefore, a major challenge is to develop efficient channels of capital in rural areas. Similarly, the amounts of private transfers reflect the level of regional developments.

Regions with lower incomes and therefore are in need of more support, actually receive lower remittances than other better-off regions.

Finally, we find a limited effect of public transfers in solving these problems. Although public transfers are clearly targeted at the regions with lower welfare, their effects on improving these statuses are not evident. In addition, there appears to be a trade-off between the number of households in receipt of public transfers and the average amount they receive. Regions with a higher proportion of households covered by the public safety net tend to have smaller received amounts. This shortcoming is reflected in the nearly identical distributions of income and total imputed budget of these regions. As households in these regions are also the lowest income earners, their livelihood is severely affected.

There are many reasons for the successes and failures of regional development. Two regions appear to “lag” behind are North West and Central South. In comparing these regions with other regions, and among themselves, we highlight several points. First, exposure to natural disasters can have severe consequences for development. We find distribution of idiosyncratic shocks of health shocks and production shocks of crop diseases and animal diseases quite similar across all regions, except for natural disasters. Central South, the most exposed to natural disasters in the forms of typhoon and extreme rainfalls, is the region with the second lowest welfare level in all welfare indicators of income, consumption and assets. However, the region with the lowest welfare level – North West – is rarely exposed to these forms of natural disasters. Comparison of North West and Central South shows that even though North West is the region most targeted for public transfers, their welfare status still lags behind Central South. One possible reason is that North West is characterised by the highest dependence on agriculture, whereas Central South has high levels of non-farm diversification. The non-farm diversification itself can be attributed

further to several reasons. The most important factor is labour force. Central South has higher average education levels and also smaller family size than North West. Apparently, this advantage of labour force is reflected in their exploiting non-farm jobs more than North West and therefore their ability to achieve resilience to shocks exposure. Apart from labour characteristics, North West is characterised by mountainous landscape with sparse population. On the contrary, Central South is characterised by the coastal plain and high population density. Central South therefore has more opportunities for non-farm diversification than North West.

However, dependence on agriculture alone cannot be blamed for the development lag in North West. The two regions that appear to “lead” are Central Highland and Mekong Delta. Of these two regions, Central Highland is highly dependent on agriculture, but the welfare indicators of income, consumption and assets are among the highest. Comparison of agricultural activities show that both regions have similarly larger agricultural land areas than other regions, but Central Highland diversify into high value cash crops, with higher labour allocation to coffee and less to rice. North West instead focus on the staple crops of rice, maize and potatoes. Therefore, even though North West has considerably large total agricultural outputs, their average income is still lower than any other regions whereas Central Highland has the second highest income of all regions. The ability of planting high-value cash crops is further attributed to the presence of highly nutritious lands in Central Highland. Because of the low returns in agriculture, the vicious circle is triggered for North West as the investment in productive assets in this region is negligible and agricultural practices are still based on rudimentary methods. In contrast, Central Highland has the highest percentage of ownership of high-value productive assets. We further find a

dwindling credit market in North West despite a very active start, another contrast with Central Highland.

Other factors are likely to contribute to the regional development. The proximity to social and economic hubs appears to have a significant impact on non-farm diversification opportunities. Red River Delta has an active labour market with equal labour allocation to agriculture, waged and businesses activities. This region ranks third in terms of welfare, after Central Highland and Mekong Delta. Central North and North East have lower welfare than these three regions, but have higher welfare than North West and Central South. Although North East is mountainous like North West, it is closer to the capital of Hanoi, and therefore is able to engage in more non-farm diversification. Central North is more exposed to more natural disasters than North East. Therefore, even though Central North and North East are quite similar in most labour and market characteristics, North East have better welfare than Central North. However, the problem of low-pay low-skill non-farm jobs in rural Vietnam is still prevalent because the average incomes of these regions, especially Red River Delta, are lower than Central Highland, despite the high level of non-farm diversification.

Mekong Delta has all distinct advantages in rural development: large scale of agricultural activities, nutritious soils for crops, developed labour market and limited exposure to natural disasters. This region consistently has the highest income levels as well as high-value asset bases and active financial markets of all seven regions.

In conclusion the heterogeneity in characteristics and economic development of different regions in rural Vietnam brings up many interesting issues for development studies. Given the endogeneity of financial markets and the difficulty in implementing public policy, the improvement in productivity of agriculture and more opportunities for non-farm

diversification appears promising. However, the quality of labour is a question worth addressing if these strategies are followed. The next few chapters will explore these issues in more detail with application of the consumption smoothing theories and the asset smoothing theory reviewed in Chapter 2. Before we present the empirical results of these tests, we discuss our measure of income shocks in the next chapter.

CHAPTER 4

Measures of Income Shocks

4.1 Introduction

Chapter 2 indicates that the tests based on the responses of consumption towards observable negative shocks are able to provide the flexibility in testing three theories CMH, PIH and AST. Using observable shocks nevertheless cannot capture the effect of other unobserved shocks. However, current approaches to measuring unobserved shocks are not suitable for testing CMH, PIH and AST and subsequent analyses using shocks as the determinants. In particular, the “common factor” approach uses shared characteristics of time and place in the sample to estimate the lower bound for covariate shocks or proxy for covariate shocks in an empirical consumption function. Common factors can be measured by region and time dummies and interaction between region and time dummy in the regression (Harrower & Hoddinott, 2005; Kochar, 1999; Morduch, 2004). Alternatively, it can be measured from average group income or consumption (Townsend, 1994) or standard deviation of income or consumption (Gaurav, 2015). Another approach is to consider the regression residuals to be the shocks (Blundell, Pistaferri, & Preston, 2008; Günther & Harttgen, 2009). Both of these approaches are subject to model specifications, and the generated income shock measures can be used for testing either CMH only (Gaurav, 2015; Townsend, 1994) or PIH only (Blundell et al, 2008).

Natural disasters are the most dangerous observable shocks for rural households who are characterised by low incomes and high dependence on agriculture. There are two approaches to measuring natural disaster shocks. One approach is to trace the times and places where the natural disasters happened and match to the locations of surveyed households. The other approach is to ask the households if they have experienced the natural disaster. There are both advantages and disadvantages to each approach. This section focuses on analysing these advantages and disadvantages.

The structure of this chapter is as follows. Section 4.2 provides a brief literature review on theoretical and empirical evidence on the tendency to report shocks. Section 4.3 describes the data used in comparing self-reported shocks to independently measured shocks. Section 4.4 describes the empirical strategy and section 4.5 discusses results of these strategies. Finally, section 4.6 concludes the chapter and proposes the measure of income shocks used in subsequent analyses.

4.2 Literature Review on Perceived Shocks

4.2.1 The Perception of Shocks

Risk perception is one key determinant of decision making in agriculture. Many studies have been conducted to analyse the effect of risk perception on the choice of crops and animals (Dill et al., 2015; Warren et al., 2016), on adoption of technologies and farm practices (Hall & Moran, 2006; Reimer, Weinkauf, & Prokopy, 2012) and on other behaviours in rural areas (Qin, 2015; Wertheim-Heck, Spaargaren, & Vellema, 2014). However, less is known about what determines the perception of risk itself. Research has consistently found that personal experience of extreme weather events positively correlates with perception of risks caused by the shocks, for example tropical cyclones (Anderson-Berry, 2003), floods (Kellens et al., 2011; Lindell & Hwang, 2008), and other coastal risks (Elrick-Barr et al., 2015). The personal experience of shocks is self-reported, and thus forms the perceived shock, which is different from the account of shocks based on weather data. The perceived future shock has been thoroughly researched in agricultural economics, but little work has been done on the perception of shock experienced in the past. This perceived shock depends upon the subjective belief of the survey respondents. For example, Anderson-Berry (2003) found that the majority of surveyed students reported previous experience of a tropical cyclone which happened before they were born. Further

investigation confirms that the students “were not lying” (Anderson-Berry, 2003, p. 217) but were influenced by stories told by family members and neighbours about the tropical cyclone. Perceived shock therefore reflects the perception of the risk itself.

Weather shocks are examples of covariate shocks, which affect households within a region at a time. Despite the severity of weather shocks, not all households in the affected region report the shock, which is referred to as *under-reporting* (Quisumbing, Kumar, & Behrman, 2012; Rakib & Matz, 2016; Tesliuc & Lindert, 2002). Households with more capacity to cope with shocks are less likely to report them. This point is made by Tesliuc and Lindert (2002, p. 19) “*the shocks hit all the households in the [population sample unit] with the same severity but most were able to mitigate its effect, and, thus, did not mention it in the survey*”. Another cause of not reporting shocks in an affected region is the spatial variability of exposure. A weather shock hits a region, but the topography is such that not all households are affected.

Elicitation of perceived shocks is a common measure of shock exposure in household surveys (Heltberg, Oviedo, & Talukdar, 2015). One type of error is that within a location where weather shocks are not recorded households report a shock experience, namely *over-reporting*. In addition to the heterogeneous topography, another possible cause is the perception of conditions being worse than they actually were, which is comparable to the well-known self-reported bias found in epidemiological studies. Health-related problems have found to be reported more by those with higher incomes or motivated by leave justification (Christiaensen, Hoffmann, & Sarris, 2007). The tendency to report shocks can also be affected by what is deemed to be the status quo. There will be a difference between the severity of shocks perceived by households exposed to a relatively high frequency of

extreme weather events and households with a low risk. In this case, the bias can lead to attenuation biases when shocks are used as explanatory variables.

4.2.2 Measurement Error in Household Survey and Validation of Self-reported Shocks

Errors are possible at any stage of a survey (Tourangeau, 1984). Bound, Brown, and Mathiowetz (2001) list three robust tenets of sources of measurement errors in a household survey: cognitive processes, social desirability and survey conditions. As survey conditions are considered similar across all households and shocks are neither desirable nor undesirable by social standards, cognitive process is the most likely cause of errors in reporting shocks. Three possible causes of cognitive failure are recall period, retrieval strategy and salience, which is defined by Bound et al. (2001, p. 3745) to be the strength of the memory trace: “*the stronger the trace, the lower the effort needed to locate and retrieve the information*”. The classical measurement errors are those where the measurement errors in dependent and explanatory variables are not correlated. In that case, using mis-reported shocks can attenuate the effect of shocks on welfare. If measurement errors are correlated, the biases can be both downward and upward, subject to the direction of the correlation between the errors and the variables (Bound et al., 2001).

There has been established research into validation of reported earnings, transfers, assets, hours worked, unemployment, occupation, education and health-related variables. Validation of shocks however has been limited, and mostly concerned with health shocks. In particular, epidemiological studies validate self-reported health shocks by comparing self-reported diseases to a *gold standard*, which are reliable objective measures of disease occurrence. Examples of common gold standards in epidemiological studies are: health insurance claims data (Robinson et al., 1997), medical records (Gupta & Jürges, 2012), general practitioner diagnoses (Baker, Stabile, & Deri, 2004) and administrative data

(Benítez-Silva et al., 2004). The likelihood of reporting a disease is found to be related with types of diseases reported, respondent characteristics, and the intensity of the problem and justification motivation. Researchers have found that gender, education levels, ages and places of residence have a connection with the likelihood of reporting errors (Okura et al., 2004). Lower-income households tend to report fewer health problems (Foster, 1994; Gertler & Gruber, 2002; Groot, 2000) and justification motivation for receipt of benefits can lead to over-reporting (Baker et al., 2004). Recently Parvathi and Nguyen (2018) found evidence of bias in self-reported income of fishermen who exploit common properties for extra income.

4.2.3 Locus of Control Hypothesis and Perceived Covariate Shocks

The locus of control refers to a set of beliefs between behaviours and resulting rewards or punishments. An external locus of control refers to the belief in luck and fate whereas an internal locus of control believes that these outcomes are determined by a person's attributes and efforts, that is, one makes one's own luck. Internal locus of control has been shown to affect the perceived benefit of a farming practice (McNairn & Mitchell, 1992) and the behaviours of farmers to overcome poverty (Lybbert & Wydick, 2016). The link of locus of control to perceived shocks was mentioned in the early days by Lefcourt (1982) in his extensive review of laboratory experiments on behaviours of humans and animals. The general finding is that shocks are not perceived by those who can control the level of exposure. Surprisingly, no identifiable work has considered this relationship in the perceived weather shocks.

Covariate shocks, which are known by many names, for example 'covariate' (Heitzmann, Canagarajah, & Siegel, 2002), 'collective' (Fafchamps, 2003), 'aggregate' (Kazianga & Udry, 2006) and 'systemic' (Heltberg et al., 2015), can be misreported. Unlike idiosyncratic shocks, which affect 'isolated individuals' (Fafchamps, 2003) and are "*uncorrelated among individuals*

and/or regions” (Heitzmann et al., 2002, p. 24), covariate shocks are factual events that happen in a specific region at a specific time. It is possible to develop a gold standard measure of covariate shocks based on information sources independent of self-reporting individuals, which is similar in nature to epidemiological studies. Weather data are suitable for constructing such a standard and have been increasingly used in analysing rural agricultural income (Carter & Lybbert, 2012; Kazianga & Udry, 2006; Paxson, 1992) and in other social studies (Dell, Jones, & Olken, 2014). In the absence of any reporting justifications, such as a consequential compensation for reporting shocks, the tendency to report shocks of a covariate nature is the net effect of covariate shocks interacted with the ability to control the extent of income and asset loss from these shocks. Since agriculture is the backbone of most rural economies in developing countries and is highly vulnerable to natural disasters, we hypothesise that the extent of dependence on agriculture will affect the reporting tendency. Households that manage to reduce their dependence on agriculture, and thus improve their perception of control over the impact of income shocks, will report fewer shocks. Apart from dependence on agriculture, in a manner similar to epidemiological studies we hypothesise that individual and household characteristics, such as age, gender, education and household size, affect the reporting tendency. However, given the covariate nature of natural disasters, a positive relationship is expected between self-reported natural disasters and weather data shocks. Depending on the relationship between agricultural diversification and welfare indicators, the perceived shocks can bias either upwards or downwards the shock effect in welfare analysis.

4.3 Data

We used the data obtained from the Vietnam Access to Resources Household Survey (VARHS). This survey has been conducted biannually since 2006 and targets poor households in rural areas of twelve provinces in Vietnam, which correspond to seven

regions: *North West* (Dien Bien, Lai Chau and Lao Cai); *North East* (Phu Tho); *Red River Delta* (Ha Tay); *Centre North* (Nghe An); *Centre South* (Quang Nam and Khanh Hoa); *Central Highland* (Dak Lak, Dak Nong and Lam Dong) and *Mekong Delta* (Long An). The VARHS originates from a group of projects funded by the Danish International Development Agency (DINIDA) in Vietnam, and uses the same sampling method as the national Vietnam Household Living Standard Survey (VHLSS). From the 2,324 households in 2006 and four survey waves of 2006-2012, we construct a balanced panel dataset of 1,915 households after exclusion of per capita income outliers (Osborne & Overbay, 2004) and households in Khanh Hoa province. Details on the survey methods and the statistical analysis of the VARHS are discussed in Chapter 3.

Floods are the most common natural disaster in Vietnam (EMDAT, 2017) and most are caused by typhoons (Imamura & Van To, 1997). Responses to questions on shocks and risk coping strategies in VARHS reflect the similar commonality of natural disasters. The exact wording of the question is “*Since 1st July 2xxx did the household suffer from an unexpected loss from any of the following shocks?*” and the surveyed respondent is asked to indicate if the household is exposed or not to a list of shocks and indicate the corresponding month and year of shock occurrence. For each survey wave, we calculate the number of times a household was hit by natural disasters and name that variable as perceived shock. Except for the year 2006, when the recall period is five years from the survey time, the 2008-2012 survey waves used a 2-year recall period. In addition, the 2006 survey wave described the shock generally as a ‘natural disaster’ but other survey waves either provided more details of floods, landslides, typhoons, storms and droughts of that category (2008), or classified them into three smaller categories of: flood/droughts, typhoons and other natural disasters

(2010-2012). To ensure comparability across the panel, we group these categories into one. We use 2006 as the base year and use 2008-2012 panel data for analysis.

Two sources of weather data were used to construct the validating shock. From the records of typhoons (UNISYS, 2017) we track the movements of storm eyes and match those to the sampled communes up to 250km from the eye of the storm, the typical typhoon radius (Ahrens, 1991). We exclude cases where typhoons weaken and become tropical depressions, which are still likely to result in high rainfall levels. In that case, we adjust by the number of times when average monthly rainfall reaches extreme values. Rainfalls taken for 14 years from 30 provincial stations in Vietnam (MARD, 2017) are matched with the nearest commune (Figure 4.1). To reduce the spatial basis risks to the minimum, we choose the lowest administrative level in Vietnam - commune - to assume that if a flood hit a commune, the sampled households residing in that commune are all affected. We calculate the total number of times in the previous 12 months when the households were hit by events deemed to be shocks by weather data.

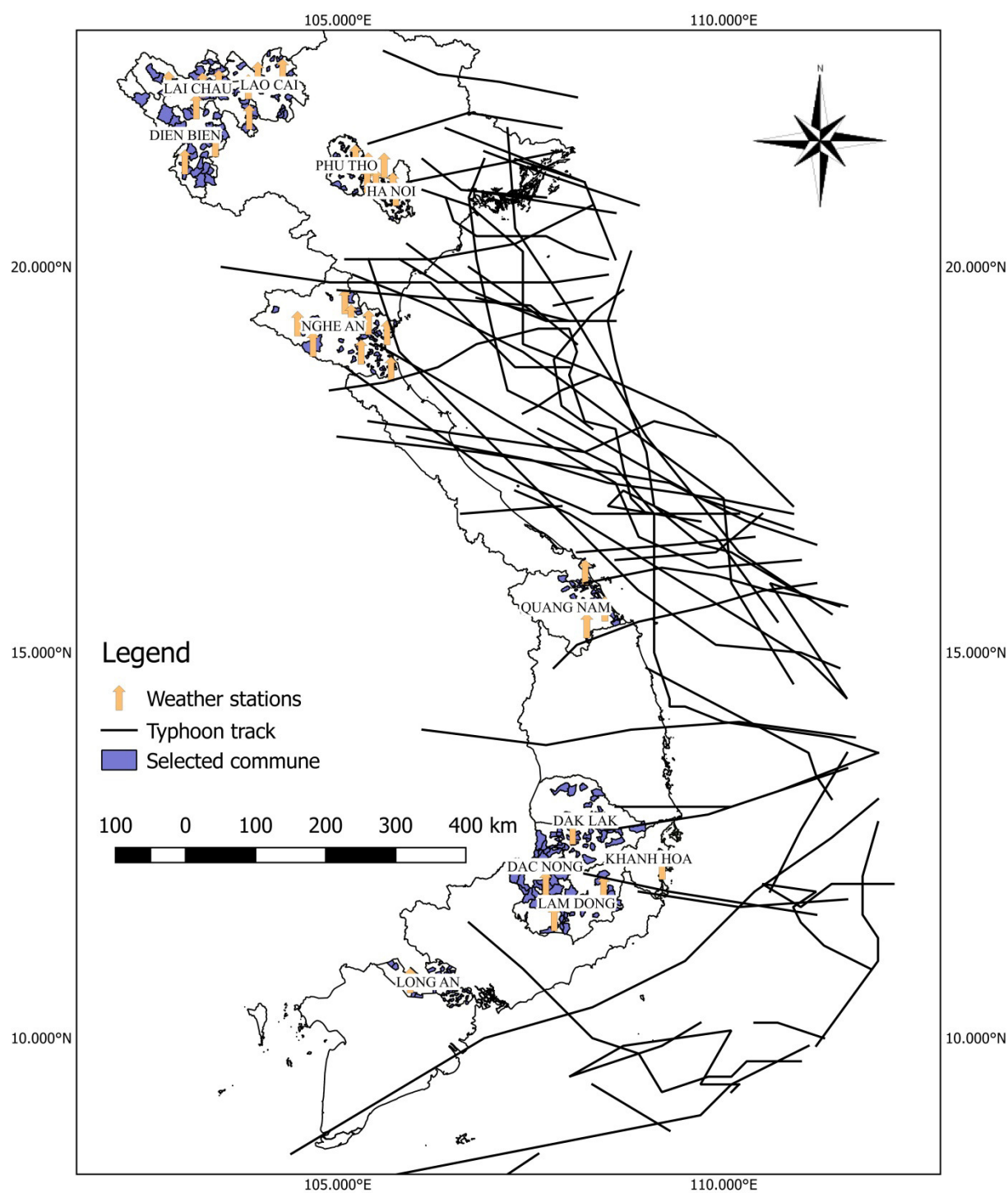


Figure 4.1: Map of the study sites and weather data shocks

4.4 Methodology

Bias of reporting shocks can be quantified by the difference between reports and objective standards (T-test, Mc Nemar test, Cochran's Q test) and the proportion of

agreement/disagreement in the sample (odd ratio, predictive positive value-PPV, Kappa statistics). Since these tests are similar in nature, Kappa statistics as described in Kriegsman et al. (1996) are used because of its wide application in epidemiological validation literature (Machón et al., 2013). To decompose bias, the Predictive Positive Value (PPV) and Predictive Negative Value (PNV) as described in Machón et al. (2013) are used. Table 4.1 elaborates on the calculations.

Table 4.1: Kappa statistics

According to Gold Standard $\tilde{\mathfrak{s}}^*$			
According to households $\tilde{\mathfrak{s}}$	Shocks present	Shocks not present	Total
Shocks present	a	b	a+b
Shocks not present	c	d	c+d
Total	a+c	b+d	n (total sample)
Kappa	$(2(ad-bc))/((a+b)(b+d)+(c+d)(a+c))$		
PPV	$a/(a+b)$		
PNV	$d/(c+d)$		

Source: Kriegsman et al. (1996) and Machón et al.(2013)

As measurement errors can lead to biased coefficients in linear regression (Bound et al., 2001), the explanatory powers of both perceived shock and weather data shock are compared in welfare analysis. Welfare is measured using labour income and public transfer. Labour income is derived from agriculture, waged activities, small businesses, exploitation of common properties and rental activities. Public transfers are funds from both government and non-governmental organisations for social support, such as health care, education and poverty alleviation. The following estimations are compared:

$$Income_{it} = \alpha_0 + \alpha_1 X_{it} + \alpha_2 Flood_{v\{i \in I_v\},t}^{weather} + \epsilon_{it}^{inc} \quad (4.1)$$

$$Income_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 Disaster_{it}^{self-report} + \epsilon_{it}^{inc} \quad (4.2)$$

$$Transfer_{it} = \gamma_0 + \gamma_1 X_{it} + \gamma_2 Flood_{v\{i \in I_v\},t}^{weather} + \epsilon_{it}^{trans} \quad (4.3)$$

$$Transfer_{it} = \delta_0 + \delta_1 X_{it} + \delta_2 Disaster_{it}^{self-report} + \epsilon_{it}^{trans} \quad (4.4)$$

where $Income_{it}$ and $Transfer_{it}$ respectively are total income earned and public transfers received by household i in survey round t ; X_{it} is a vector of characteristics of household i in community v ; $Flood_{v\{i \in I_v\},t}^{weather}$ is the discrete value of weather data shock which are the number of shock incidents affecting community v at time t and $Disaster_{it}^{self-report}$ is the discrete value of self-reported natural disasters which are the number of shock incidents reported by household i at time t . Multi-level regression was used to allow for the panel characteristics of the data and ϵ_{it}^{inc} , ϵ_{it}^{inc} , ϵ_{it}^{trans} , ϵ_{it}^{trans} were the corresponding i.i.d errors in these models.

After evaluating the discrepancy between reported natural disasters and weather data shock, the hypothesised sources of discrepancy are tested in the following model

$$\Pr(Disaster_{it}^{self-report} = r_{it} | X_{it}, Z_i) = \frac{\exp(-\lambda_{it})(\lambda_{it})^{r_{it}}}{r_{it}!}, \quad (4.5)$$

$$r_{it} = 0, 1, 2, \dots; \log \lambda_{it} = \phi_i + \theta_1 X_{it} + \theta_2 Z_i + \zeta_{it}$$

where r_{it} is the count value of perceived shocks of household i in survey round t ; λ_{it} is the expected value of the Poisson distribution; X_{it} are varying household characteristics; Z_i are household time-invariant characteristics; ϕ_i is the household specific effect. The exposure effect is not included in (4.5) because the retrospective time length is 2 years for all survey rounds for all respondents. In the random effects model, ϕ_i is assumed to follow log gamma distribution and be independent of X_{it} and Z_i . In the fixed effects model, ϕ_i is assumed to be dependent and since the likelihood function is conditioned on the sum over time of all the counts for each household, ϕ_i is eliminated from the result. Only time-varying household characteristics are included in the fixed-effects model. Because the number of perceived shocks is censored at 3, the model was adjusted for right censorship.

As a large proportion of households reported no shocks, the zero-inflation model is also used for comparison.

Finally, using weather data shock as the validator, the tendency to misreport natural disasters is evaluated by two separate Probit regressions:

$$Probit(Under_{it} = 1) = \psi_0^{under} + \psi_1^{under} X_{it} + \psi_2^{under} Z_i + \varsigma_{it}^{under} \quad (4.6)$$

$$Probit(Over_{it} = 1) = \psi_0^{over} + \psi_1^{over} X_{it} + \psi_2^{over} Z_i + \varsigma_{it}^{over} \quad (4.7)$$

where $Under_{it}$ is the under-reporting tendency of the household i in survey round t when the weather data shock happened and $Over_{it}$ is the over-reporting tendency of the household i in survey round t when the weather data shock did not happen. $Under_{it} = 1$ if the household did not report shocks and 0 if otherwise. $Over_{it} = 1$ if the household reported shocks and 0 if otherwise.

4.5 Results and Discussion

4.5.1 Descriptive Statistics

Household incomes are deflated to the 2010 value using the Consumer Price Index (CPI) and then converted to US\$ using the Purchasing Power Parity (PPP) in 2010. The sample represents relatively poor rural households in Vietnam. Average annual per capita income is slightly more than 2,000 US\$ and 42% of the sample are below the 2US\$/day poverty line in 2008 (Figure 4.2a). However, the situation has consistently improved with only 14% under the poverty line in 2012. Similar to other studies on poor rural households (Dercon & Krishnan, 2000; Fafchamps, Udry, & Czukas, 1998), the sample fail to smooth their consumption as their food expenditure closely tracks income (Figure 4.2b). We therefore focused on analysing the shock effect on income and public transfers, which accounts for approximately 1/3 of per capita income (Table 4.2). The vulnerability of these households is further evidenced by their exposure to natural disasters. Weather data indicate that

extreme events occur every other year on average, and the number of shocks can be as many as five events in a year (Table 4.3). However, the reported number of natural disasters is much smaller, despite the fact that the reported number is for more categories of natural disasters, and over twice as long as the time span of weather shocks.

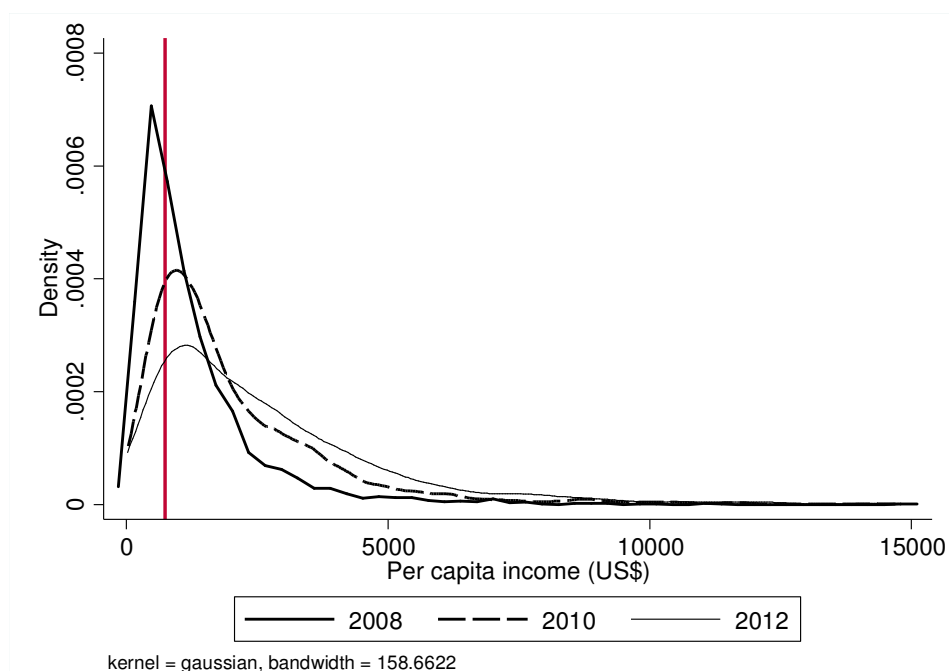


Figure 4.2 (a) Distribution of per capita income by year

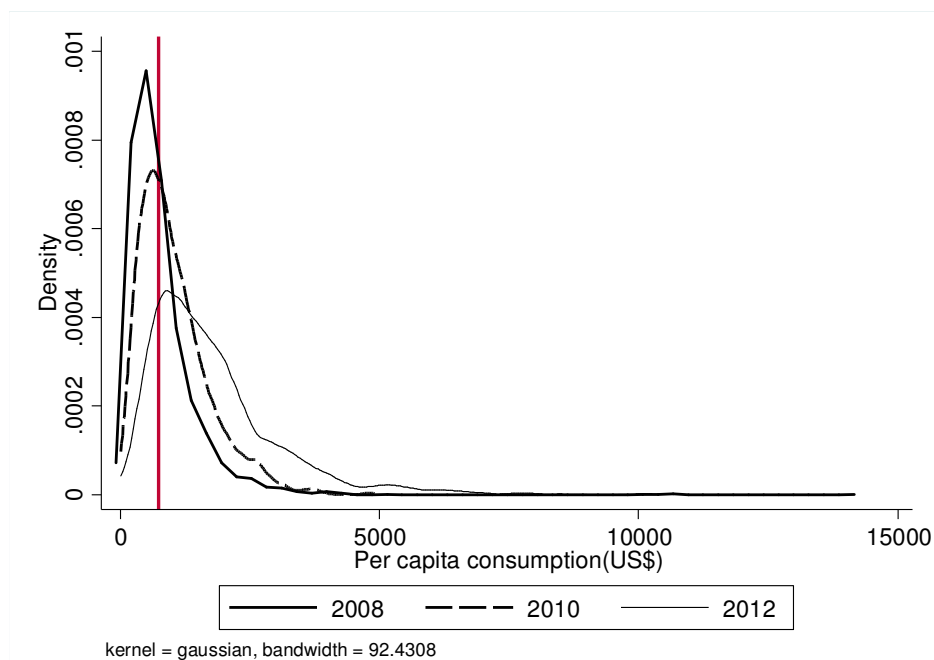


Figure 4.2(b) Distribution of per capita food consumption by year

The red line indicates the poverty line of 2\$/day. 43 obs with per capita income >\$15k are excluded

Other characteristics are typical of rural households in Vietnam (Table 4.2a). The average family size is 4-5 members, with the majority being male and of working age from 17 to 60 years old. Most household heads are male, over 50 years old and have completed primary school education. As can be seen from the previous chapter, most agricultural households are pluri-active (see section 3.5.2). As noted by many authors (Buchenrieder, 2005; Fuller, 1990), pluri-active agricultural households engage in different non-farm activities for different reasons, for example to raise socio-economic status and to struggle for survival when agricultural revenue is not sufficient. However, they differ from non-agricultural households in their high dependence on agriculture. Figure 3.7 shows that 90% of the sample participate in agriculture, but only 20% depend on agriculture as the *only* source of income, and nearly 70% diversify into waged and small business activities. However, both activities are low-skilled waged jobs, such as builders, and require small investments, such as food vendors. This structure remains quite stable from 2006 to 2012, with a slight but insignificant decrease in the agricultural household's proportion. As 99% of the sample engage in agriculture, waged and business activities, we calculated the total labour days of a household as the sum of days all members spend on these three activities. On average, households spend half of their labour days on agriculture, about 35% on waged activities and only 15% on business activities.

Division of the households into four types based on their major activity reveals marked differences in agricultural land area and education levels of the household head (Table 4.2b). More than 50% of the sample are agricultural households and they have the lowest average education levels, the largest average land area and the lowest average per capita income. Waged households rank next and business households have the highest per capita income. More agricultural households receive public transfers than other types of households but the amounts are small and comparable to business households. Interestingly the number of reported shocks is highest among agricultural households and much lower for waged and small business households, which contrasts weather shocks.

Table 4.2: Summary statistics (N=1,915, T=2008-2012)*Panel A: All sample*

Variable	Explanation	Mean	Std.Dev
Per capita income (US\$)	Per capita labour income from agriculture, wage, small business, exploitation of common properties and rental.	2,171	3,256
Public transfer (US\$)	Public transfers from governmental and non-governmental for education, health care, poverty alleviation etc. purposes	603	1,893
Public transfer receipt	% of households with receipt of public transfers	44%	50%
Weather data shocks	No. of shocks that are the extreme values of rainfall distribution and the incidents of typhoon that occur in the previous 12 months	0.47	0.99
Perceived shocks	Self-reported no. of natural disasters in the previous 24 months	0.25	0.49
Health shocks	% of total days without normal activities of all family members	0.03	0.06
Size	Household size	4.45	1.72
Labour	% of total members in labour age 17-60 years old	65%	27%
Children	% of total members under 10 years old	11%	15%
Gender=Male	Gender of household heads (1=Male, 0=Female)	0.80	0.40
Male member	% of total members being male	49%	19%
Land	Area of agricultural land (hectare)	0.74	1.38
Age	Age of household head	52.28	12.97
Agriculture labour allocation	% of total labour days spent on agriculture activities	52%	36%
Wage labour allocation	% of total labour days spent on waged activities	33%	34%
Business labour allocation	% of total labour days spent on business activities	13%	26%
Education	No. of school years of household head	6.68	3.57

Panel B: Difference in characteristics of income types

	Agriculture	Wage	Business	Mixed
Per capita income (US\$)	1,846	2,287	3,005	2,525
Public transfer (US\$)	576	706	509	671
Public transfer receipt	0.50	0.40	0.31	0.34
Weather data shocks	0.44	0.56	0.43	0.50
Self-report shocks	0.30	0.20	0.15	0.21
Health shocks	0.03	0.02	0.03	0.02
Size	4.62	4.38	4.03	4.27
Labour	0.63	0.67	0.64	0.69
Children	0.11	0.11	0.10	0.11
Gender=Male	0.85	0.69	0.79	0.84
Male member	0.50	0.48	0.49	0.49
Land	1.01	0.41	0.42	0.46
Age	51.70	53.34	52.95	51.59
Agriculture labour allocation	0.68	0.34	0.29	0.39
Wage labour allocation	0.24	0.56	0.25	0.39
Business labour allocation	0.06	0.08	0.43	0.22
Education	6.22	6.92	7.53	7.66
No. of HH	1,043	462	292	118

*Type refers to activity that the household spend most (>50%) total family labour days on. We use 2006 as the benchmark.

Panel C: Difference in regional characteristics

	North West	North East	Red River Delta	Centre North	Centre South	Central Highland	Mekong Delta
Per capita income (US\$)	1,254	1,983	2,573	1,506	1,582	2,876	3,034
Public transfer (US\$)	305	1,023	792	1,231	417	375	186
Public transfer receipt	0.71	0.39	0.32	0.54	0.54	0.42	0.22
Weather data shocks	0.16	-	-	0.43	1.71	0.95	0.33
Self-report shocks	0.19	0.34	0.16	0.41	0.35	0.34	0.04
Health shocks	0.02	0.03	0.02	0.04	0.03	0.03	0.03
Size	5.37	4.01	4.29	4.30	4.10	4.86	4.18
Labour	0.64	0.67	0.67	0.63	0.60	0.62	0.68
Children	0.15	0.09	0.10	0.10	0.10	0.13	0.10
Gender=Male	0.90	0.78	0.78	0.83	0.74	0.84	0.74
Male member	0.50	0.49	0.49	0.49	0.47	0.50	0.49
Land	1.00	0.38	0.23	0.62	0.34	1.40	1.47
Age	47.9	53.8	52.4	54.2	56.0	48.1	54.5
Agriculture labour allocation	0.78	0.55	0.38	0.54	0.46	0.63	0.40
Wage labour allocation	0.16	0.32	0.39	0.34	0.37	0.26	0.46
Business labour allocation	0.05	0.13	0.22	0.10	0.15	0.10	0.12
Education	4.04	8.10	7.70	8.10	6.52	6.94	5.38
No. of hhs	281	254	422	178	260	265	255

Division of the households into regional location reveals more remarkable differences (Table 4.2c). North West have the highest labour allocation rate in agriculture, the lowest education level and the lowest per capita income. Centre North and Central South rank next in terms of per capita income but their education levels and labour allocation rates in non-farm activities were higher than those in North West. Central Highland have the second largest labour allocation rate in agriculture but their per capita income was the second highest. With high education levels, households in this region grew many cash crops, especially coffee, on the basaltic soil. Notably, weather data shocks indicated that the central regions, especially Central South, are most exposed to natural disasters but reported disasters spread evenly across seven regions.

4.5.2 Quantification of Self-reporting Bias

Table 4.3 describes the reporting pattern by year. Generally, few households reported more than one shock. Agreement of no shock occurrence between two sources of data is quite high and consistently increases from 50% in 2008, to 56% in 2010 and to 69% in 2012. Using weather data shocks as the *gold standard* we find PNV is remarkably high and increasing from 0.66 in 2008 to 0.78 in 2010 and to 0.80 in 2012, whereas PPV is decreasing from 0.45 in 2008 to 0.42 in 2010 to only 0.07 in 2012. These statistics mean that when weather data indicate no shocks, households are highly likely to report no shocks. However, when weather data indicate shock occurrence, not all households reported shocks and the under-reporting incidents increase with time. Kappa statistics performance is worse with the highest value of only 0.2 in 2010. It is 0.09 in 2008 and even negative -0.12 in 2012.

Table 4.3: Cross-validation of self-reported shocks and weather data shocks by year

(N=1,915 T=2008-2012)

		No. of perceived shocks				Kappa	PPV	PNV
		0	1	2	3			
2008	No. of weather data shocks	0	950	221	36	0.09	0.45	0.66
		1	439	180	12			
		2	60	14	3			
2010	No. of weather data shocks	0	1,076	281	32	0.20	0.42	0.78
		1	83	44	10			
		2	19	28	1			
		3	45	28	6			
		4	140	85	3			
2012	No. of weather data shocks	5	11	19	2	(0.12)	0.07	0.80
		0	1,319	216	33			
		1	292	15	3			
		2	36	0	0			

Comparison of two shock datasets by region shows two patterns (Table 4.4). Central regions have higher agreement rates than other regions. Northern central households are more likely to over-report whereas Southern households under-report. Notably, Central

North, the least affected central region according to weather data, over-reports by 38%, whereas Central South and Central Highland, the most affected regions, over-report by 18%. Kappa statistics of the Central South and Central Highland are the highest, at 0.17 and 0.12 respectively. For both regions, PPV is much higher than PNV, at 0.74-0.81 and 0.42-0.40 respectively. Other regions have almost nil or even negative Kappa statistics (North West, Central North), and have PNV much higher than PPV. These statistics show the disadvantage of weather data in capturing the general pattern of shock occurrence. Because of the limited sources of data (weather stations and typhoon tracks), we fail to control for other effects. For example, the storm circulation phenomenon can lead to adverse effects on the region where typhoons did not land, or the mountainous topography can turn average rain fall into dangerous flash floods.

Table 4.4: Regional cross-validation of self-reported shocks and weather data shocks

(N=1,915 T=2008-2012)								
No. of weather data shocks		No. of perceived shocks				Kappa	PPV	PNV
		0	1	2	3			
North West (843obs.)	0	568	133	8		(0.10)	0.08	0.82
	1	121	13	0				
North East (762obs.)	0	537	193	32		-	-	1.00
Red River Delta (1266obs.)	0	1,074	176	16		-	-	1.00
Centre North (534obs.)	0	224	115	21	2	(0.09)	0.27	0.65
	1	76	34	2	0			
	2	46	12	2	0			
Centre South (780obs.)	0	213	33	14		0.17	0.81	0.40
	1	166	87	7				
	4	140	85	3				
Central Highland (795obs.)	5	11	19	2		0.12	0.74	0.42
	0	133	22	1	0			
	1	74	34	1	0			
	2	22	28	1	0			
Mekong Delta (765obs.)	3	34	24	6	1	0.04	0.48	0.67
	0	494	16	0				
	1	240	12	3				

Compared to epidemiological studies with Kappa statistics between 0.3-0.9 and PPV between 0.30-0.15 (Kriegsman et al., 1996; Machón et al., 2013), the discrepancy between reported shocks and weather data shocks is substantial. We use factor analysis of all reported shocks other than reported natural disasters to check if natural disasters were wrongly misclassified into other types of shocks (Table 4.5). This appears not a problem as Kaiser-Meyer-Olkin statistics indicate inappropriateness of factor analysis and reported shocks show negligible pairwise correlation coefficients.

Table 4.5: Factor analysis and correlation matrix of self-reported shocks

Variable	Factor1	Factor2	Factor3	Factor4	Factor5	Uniqueness
Natural disasters	0.161	(0.129)	(0.008)	(0.000)	0.002	0.957
Serious illness, injury or death	0.030	0.056	0.116	(0.005)	0.026	0.982
Other shocks	0.035	0.058	(0.088)	0.074	0.020	0.982
Crop diseases	0.210	(0.042)	(0.012)	0.027	0.017	0.953
Animal diseases	0.190	0.076	0.013	(0.011)	(0.022)	0.958
Input prices	0.107	0.109	(0.029)	(0.080)	0.002	0.970
Unemployment	(0.025)	0.145	(0.046)	(0.000)	0.033	0.975
Unsuccessful investment	0.038	0.081	0.087	0.064	(0.006)	0.980
Land loss	(0.008)	(0.065)	0.020	(0.022)	0.069	0.990

Kaiser-Meyer-Olkin measure of sampling adequacy: 0.5098

	Natural disasters	Serious illness, injury or death	Other shocks	Crop diseases	Animal diseases	Input prices	Unemployment	Unsuccessful investment	Land loss
Natural disasters	1.000								
Serious illness, injury or death	(0.014)	1.000							
Other shocks	(0.011)	(0.016)	1.000						
Crop diseases	0.070	0.013	0.024	1.000					
Animal diseases	0.020	0.010	0.010	0.051	1.000				
Input prices	0.003	0.008	(0.002)	0.013	0.055	1.000			
Unemployment	(0.033)	0.003	0.024	(0.007)	(0.005)	0.032	1.000		
Unsuccessful investment	(0.007)	0.026	0.004	0.003	0.029	(0.011)	0.012	1.000	
Land loss	0.012	0.008	(0.006)	0.005	(0.017)	(0.004)	(0.005)	(0.009)	1.000

4.5.3 Welfare Analysis

Table 4.6 provides estimations for equations 4.1 to 4.4 for total incomes and public transfers. We additionally applied log transformation to account for the log-normal distribution of income.

In the income regression (Table 4.6a), perceived shocks brings out larger shock effects on the income losses than weather data shocks, with or without log transformations. One incident of self-reported natural disaster reduces total income by 11% or 5 mil VND (1000 PPP\$), whereas one incident of weather data shock reduces total income by 5% or 2mil VND (400 PPP\$). This probably is due to the spatial basis risk in using weather data to proxy for shock effects. As mentioned before, weather data fail to capture the local specificity that can distort the shock effects. Even though we use the smallest administrative level, there still exists heterogeneity within a rural commune of Vietnam. Except for the difference in shock effects, the effects of household characteristics are quite consistent across two specifications. Health shocks consistently reduce income whereas percentage of aged labourers, education and age consistently increased earning ability. Ownership of a large land area is also associated with higher incomes.

In the public transfer regression (Table 4.6b), weather data shocks and perceived shocks bring out contradictory effects of shocks. Public transfers are reduced significantly when weather data shocks happen, which may be due to a budget effect. On the other hand, perceived shocks are associated with a significant increase in logged public transfers, but an insignificant decrease in non-logged public transfers. The safety net's reduced outreach to distressed households by natural disasters has been mentioned in the literature. Fafchamps (2003) lists the difficulties in delivering aid to remote rural areas as one of the reasons why international aid accounted for the small proportion of total transfers received by surveyed

households during the 1984 Burkina Faso drought. He also cites evidence where households that were worst hit received less aid than those less affected (Fafchamps, 2003, p. 54). If the effect captured by weather data shocks is true, using perceived shocks instead of weather data shocks can lead to a policy oversight. Except for the shock effects, the effects of household characteristics are consistent whether perceived shocks or weather data shocks were used.

Table 4.6: Effect of shocks on the general welfare (N=1,915)

Panel A: Income

	Log total income		Total income	
	(1)	(2)	(3)	(4)
Weather data shock	-0.046*** (0.01)		-2,283*** (543)	
Perceived shock		-0.111*** (0.022)		-5,289*** (1075)
Health shocks	-0.979*** (0.31)	-0.94*** (0.309)	-37,189 (26607)	-35,329 (26645)
Size	0.178*** (0.015)	0.176*** (0.015)	6,649*** (1765)	6,571*** (1763)
Labour	1.04*** (0.108)	1.032*** (0.108)	49,932*** (9104)	49,580*** (9119)
Children	0.044 (0.151)	0.058 (0.153)	1,004 (14137)	1,638 (14146)
Education	0.046*** (0.008)	0.044*** (0.008)	2,898*** (675)	2,845*** (677)
Age	0.101*** (0.026)	0.1*** (0.027)	5,480*** (1477)	5,415*** (1488)
Age square	-0.001*** (0)	-0.001*** (0)	-32** (13)	-31** (13)
Gender	-0.006 (0.119)	-0.008 (0.119)	12,393* (6837)	12,315* (6794)
Male member	0.189 (0.151)	0.177 (0.15)	-8,637 (8744)	-9,234 (8708)
Land (log)	0.067*** (0.023)	0.07*** (0.023)		
Land			169,430 (317257)	178,597 (317553)
Constant	4.589*** (0.845)	4.641*** (0.852)	-228,327*** (42861)	-224,832*** (43193)
<i>Within R²</i>		0.141	0.142	0.040
<i>Between R²</i>		0.142	0.146	0.031
<i>Overall R²</i>		0.136	0.140	0.0306

Estimation is fixed effects multi-level regression using stata –xtreg–, robust standard errors in brackets; *, **, *** for 10%, 5% and 1% significance levels.

Panel B: Public transfers

	Log public transfer ⁺		Public transfer	
	(1)	(2)	(3)	(4)
Weather data shock	-0.201** (0.096)		-951*** (219)	
Perceived shock		0.56*** (0.199)		-67 (449)
Health shocks	7.681*** (1.671)	7.53*** (1.673)	12,867*** (3727)	12,688*** (3742)
Size	0.278*** (0.081)	0.279*** (0.081)	644*** (186)	640*** (187)
Labour	-2.996*** (0.545)	-3.005*** (0.545)	-8,170*** (1249)	-8,129*** (1254)
Children	-0.752 (0.946)	-0.774 (0.946)	97 (2171)	108 (2180)
Education	-0.142*** (0.038)	-0.14*** (0.038)	302*** (88)	303*** (88)
Age	0.025 (0.061)	0.029 (0.061)	279** (139)	292** (140)
Age square	0.001 (0.001)	0.001 (0.001)	0.283 (1.203)	0.183 (1.207)
Gender	-0.108 (0.385)	-0.136 (0.384)	-830 (904)	-827 (907)
Male member	-1.269* (0.737)	-1.22* (0.736)	-1,661 (1715)	-1,619 (1720)
Land (log)	-2.061 (9.712)	-2.45 (9.712)		
Land			-26,585 (22810)	-26,452 (22899)
Constant	-1.023 (1.784)	-1.401 (1.782)	-18,912*** (4117)	-19,810*** (4130)
<i>Wald Chisq</i>		256***	260***	309***
				290***

⁺ We take log of values of public transfer after adding 1,000 VND so that those who don't report receipt of public transfers will have zero log values. Estimation is made by using stata `-xttobit-` for random effects multi-level regression; *, **, *** for 10%, 50% and 1% significance levels.

4.5.4 Source of Self-reporting Bias

Part of the inconsistency in explaining the shock effect between the two sources of data can be attributed to the pattern of reporting shocks (Table 4.7). Columns (1)-(3) consider both intra- and inter-household differences, whereas column (4) considers only intra-household differences in explaining the shock reporting pattern.

Table 4.7: Tendency to report shocks

Dependent variable: No. of perceived shocks	Random effects ⁺	Right-Censor	Zero-Inflated	Fixed effects ⁺⁺
	(1)	(2)	(3)	(4)
<i>Shock-reporting variables</i>				
Weather data shocks	0.099*** (0.024)	0.099*** (0.024)	0.103*** (0.025)	0.099*** (0.025)
Health shocks	0.513 (0.364)	0.514 (0.364)	0.783** (0.364)	1.33** (0.673)
Land (log)	0.165*** (0.018)	0.165*** (0.018)	0.128*** (0.019)	0.018 (0.069)
Age	-0.008*** (0.002)	-0.008*** (0.002)	-0.006*** (0.002)	-0.025*** (0.008)
Labour allocation for non-agricultural activities	-0.466*** (0.082)	-0.466*** (0.082)	-0.009 (0.112)	-0.382*** (0.144)
Education	-0.024*** (0.008)	-0.024*** (0.008)	-0.023*** (0.008)	-0.041** (0.019)
Regions (base= North West)				
<i>North East</i>	1.03*** (0.109)	1.03*** (0.109)	0.911*** (0.11)	
<i>Red River Delta</i>	0.426*** (0.115)	0.426*** (0.115)	0.445*** (0.119)	
<i>Centre North</i>	1.19*** (0.108)	1.191*** (0.108)	1.111*** (0.109)	
<i>Centre South</i>	0.93*** (0.117)	0.93*** (0.117)	0.767*** (0.121)	
<i>Central Highland</i>	0.591*** (0.103)	0.592*** (0.103)	0.565*** (0.103)	
<i>Mekong Delta</i>	-1.189*** (0.195)	-1.189*** (0.195)	-1.38*** (0.237)	
Constant	-2.615*** (0.217)	-2.615*** (0.217)	-2.384*** (0.225)	
<i>Zero-Inflation variables</i>				
Labour allocation for non-agricultural activities			18.253*** (4.875)	
Regions (base= North West)				
<i>North East</i>			-0.299 (1.494)	
<i>Red River Delta</i>			1.125 (1.403)	
<i>Centre North</i>			0.847 (1.508)	
<i>Centre South</i>			-1.169 (1.456)	
<i>Central Highland</i>			-0.05 (1.418)	
<i>Mekong Delta</i>			-4.233 (11.44)	
Constant			-16.801*** (4.881)	
No. of households	1,915	1,915	1,915	933
No. of observation	5,745	5,745	5,745	2,799
Wald Chi ²	2,970***	2,588***	292***	47***

Robust standard errors in brackets; *, **, *** for 10%, 5% and 1% significance levels.

⁺Test statistics show that results are not different from pooled regression using standard errors clustered at household levels. ⁺⁺982 households (2,946 observations) are omitted because of no shocks ever reported during the 3 year period 2008-2012; Time-invariant provincial effects are also omitted.

In all specifications, weather data shock is significant and consistent in predicting perceived shock. One incident of weather data shock leads to approximately 10% increase in the mean of reported shocks. This testifies to the covariate nature of natural disasters. Our hypothesis of the positive relationship between perceived shocks and weather data shocks is thus confirmed. The coefficients of models with or without adjustments for right censorship are almost identical (column 1-2). Households with larger agricultural land areas are more likely to report shocks. Larger land areas possibly are associated with larger exposure to natural disasters and more likelihood of the household being affected. However, when we control for the land effect, households that participate in non-farm activities are significantly less likely to report shocks. For every 1% increase in the number of days that households spend on either waged or business activities, the average number of reported shocks is reduced by approximately 37%. Given the small agricultural plots of rural Vietnam, our results therefore provide support for the locus of control hypothesis: the tendency to report natural disasters among poor rural households is highly motivated by the dependence on agriculture for income generation. For rural households, non-farm diversification has been shown to increase incomes (De Janvry & Sadoulet, 2001; Rigg, 2006) and help households maintain income when lost due to agricultural shocks (Meert et al., 2005). As a result, reported shocks are likely to capture the low-income effect of households with high dependence on agriculture. These households not only have lower income but also were more vulnerable to the damages of natural disasters. Reported shocks therefore reflect the household's low coping capacity with adverse conditions. Similarly, high education associated with high earning ability reduces the tendency to report shocks. Since households with older heads earn higher incomes and therefore should have better

coping capacity (Table 4.5a), we interpret the negative effect of age on the number of reported shock as the recall bias due to old age.

In addition to household characteristics, regional effects are highly significant. Compared to North West, all other regions except Mekong Delta and Central Highland are more likely to report shocks. Households in Central South, the most exposed to natural disasters, have a higher tendency to report shocks than in Red River Delta and Central Highland, but not as high as Centre North and surprisingly as North East - the region without any records of weather data shocks. The high frequency of weather shocks in Centre South probably leads to the higher tendency not to report shocks compared to Centre North and North East. Contrary to North West, Mekong Delta is characterised by the highest participation rate in waged activities and Central Highland have higher levels of non-farm diversification. The comparatively low frequency of reported shocks in these regions is possibly due to comparatively low dependence on agriculture.

Besides income, reported shocks are also likely to capture the responsiveness of public transfers to dependence on agriculture. Our results show that households with more than 50% of labour allocation to agricultural activities have a higher chance of receiving public transfers. However, other reasons could contribute to the reporting tendency. The rate of participation in agriculture in North West is the highest of all regions, but households in this region are less likely to report shocks than all other regions, except Central Highland and Mekong Delta. Apart from the fact that this region is not exposed to natural disasters as indicated by the weather data shocks, the amount of public transfers appears to matter. Centre North and North East have a high frequency of perceived shocks and they are also two regions with the highest average amounts of received public transfers.

As can be seen from column (3), the tendency to report no shocks is strongly determined by the extent the household engages in non-farm diversification, and is independent of the regional exposure to natural disasters. After controlling for the zero-shock reporting tendency, the effects of household and regional characteristics are the same except for non-farm diversification and health shocks. Non-farm diversification no longer is significant whereas health shock strongly predicts reported shocks. For a 1% decrease in the number of days lost due to health shocks, the average number of reported shocks is increased by 14%. When we consider intra-household differences only, the effect of health shocks becomes much stronger, whereas the effects of other household characteristics are similar, except that land areas became insignificant, possibly due to the stability of land areas through time. The effects of the household and regional characteristics are consistent in testing over- and under-reporting (Table 4.8). Dependence on agriculture consistently reduces the under-reporting tendency and increases the over-reporting tendency. Households with larger agricultural land areas and less participation in non-farm activities over-report more. Older household heads under-report more. Education levels significantly reduce the tendency to over report and increase the under-reporting tendency, but not significantly. Households in regions with more exposure to shocks over-report more. Compared to North West regions, all central regions are less likely to under-report shocks.

Table 4.8: Tendency to misreport shocks

	Under-report ⁺	Over-report
Health shocks	-0.67 (0.507)	0.339 (0.402)
Land (log)	-0.099*** (0.021)	0.124*** (0.018)
Age	0.008*** (0.003)	-0.005** (0.002)
Labour allocation for non-agricultural activities	0.578*** (0.119)	-0.379*** (0.076)
Education	0.006 (0.011)	-0.024*** (0.007)
Regions (base= North West)		
<i>North East</i>		0.675*** (0.087)
<i>Red River Delta</i>		0.255*** (0.085)
<i>Centre North</i>	-1.133*** (0.2)	0.962*** (0.101)
<i>Centre South</i>	-1.464*** (0.18)	0.352*** (0.118)
<i>Central Highland</i>	-1.048*** (0.172)	0.148 (0.105)
<i>Mekong Delta</i>	-0.001 (0.209)	-0.81*** (0.128)
Constant	1.694*** (0.28)	-1.541*** (0.217)
No. of households	1,086	1,874
No. of observation	1,579	4,166
Wald Chisq	202***	299***

⁺ Only 5 regions have under-reporting problems. We use North West as the base region in analyzing under-reporting; Probit regression, standard error clustered at household levels. *, **,*** for 10%,5% and 1% significance levels.

The role of non-farm diversification in determining shock reporting tendency necessitates the examination of diversification motivation. If households diversify because of higher productivity, the diversification is associated with better welfare. However, if their diversification strategy responds to adverse conditions in production, such as rainfall uncertainty (Menon, 2009) or crop loss (Cameron & Worswick, 2003), their welfare is not as guaranteed. In our sample, the pluri-active agricultural households are likely to engage in low-skilled non-farm activities to maintain livelihood when agricultural incomes decrease. Their incomes therefore cannot compare to those who stay in agriculture but achieve high productivity because of highly developed skills. However, because of the locus of control effect households who diversify into low-skilled non-farm activities tend to report shocks

less than those who stay in agriculture with advanced skills. If that is the case, reported shocks could have a positive effect on income. To test this hypothesis, we interact the shock variables with the education levels in the income regression. We then compare the linear combination of shock and the interaction coefficients. Figure 4.3 plots the changes in the linear combination of coefficient values as number of shocks increase from 1 to 3. Interestingly, the higher the number of perceived shocks, the more positive the effect is. On the contrary, the higher the number of weather data shocks, the more negative the effect is. Use of perceived shock therefore does not always reflect the true welfare status of the households. Our results support the recent findings by Gautam and Andersen (2016) that diversification leads to a high inequality of income and well-being among rural households because only those with better social and human capitals can access high-return sectors. We additionally show that those who diversify into low-return sectors have lower incomes than would otherwise be the case

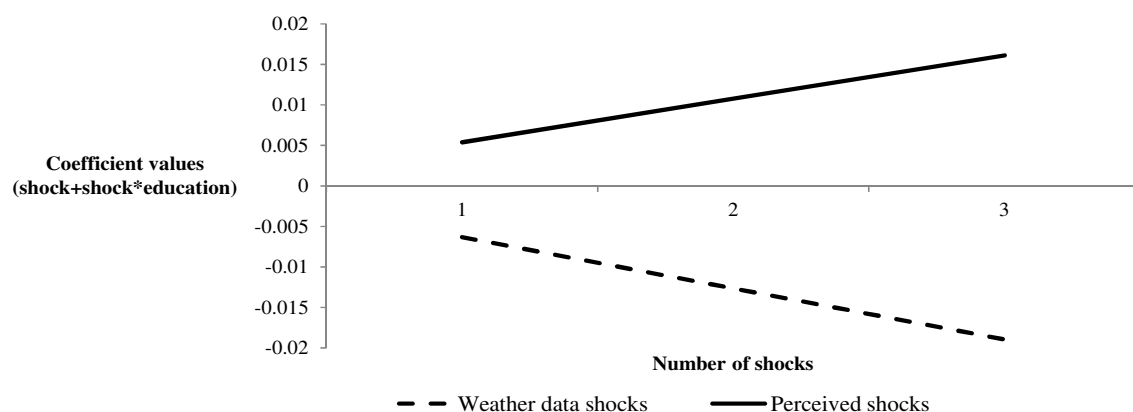


Figure 4.3: Comparison of interaction between shocks and education levels

As a final test, we include the residuals in the count model that predicts the number of perceived shocks in models (1)-(4). Results showed that the residuals are highly significant in all specifications, suggesting the high endogeneity of perceived shocks (Table 4.9). Compared to the model where endogeneity of perceived shocks is not considered (Table

4.6), the welfare effects of shocks in decreasing income and increasing public transfers are significantly larger. Using the exogenous weather data shocks to instrument perceived shocks apparently corrects for the shortcomings of two sources of data: the spatial basis risk in using weather data shocks and the self-reporting bias of perceived shocks.

Table 4.9: Endogeneity test of self-reported shocks

	Log total income	Total income	Log transfer	Transfer
	(1)	(2)	(3)	(4)
Perceived shock	-2.913*** (0.227)	-88,909*** (14,792)	5.42*** (0.908)	5,752*** (2,129)
Perceived shock regression residuals	2.832*** (0.228)	84,519*** (14,817)	-5.156*** (0.928)	-6,066*** (2,170)
Health shocks	-0.568* (0.305)	-23,738 (27,255)	6.374*** (1.729)	11,734*** (3,762)
Size	0.166*** (0.015)	6,314*** (1,778)	0.327*** (0.082)	662*** (187)
Labour	0.996*** (0.105)	48870*** (9,146)	-2.763*** (0.555)	-7,919*** (1,256)
Children	0.084 (0.147)	1,902 (14,132)	-0.575 (0.965)	278 (2181)
Education	0.026*** (0.008)	2,290*** (690)	-0.156*** (0.038)	315*** (88)
Age	0.092*** (0.026)	5142*** (1,468)	0.036 (0.062)	294** (140)
Age square	-0.001*** (0)	-31** (13)	0.001 (0.001)	0.252 (1.208)
Gender	0.028 (0.114)	13,399** (6,716)	-0.291 (0.387)	-979 (906)
Male member	0.141 (0.147)	-10,393 (8,621)	-1.089 (0.747)	-1,493 (1,719)
Land (log)	0.171*** (0.024)		-13.887 (10.206)	
Land		390,658 (369,122)		-41,125* (23,702)
Constant	5.102*** (0.833)	-188,302*** (43,447)	-3.124*(1.827)	-21,732*** (4,187)
Within R	0.183	0.045		
Between R	0.188	0.063		
Overall	0.177	0.049		
Wald χ^2			276.04***	298.3***

Estimation is fixed effect multi-level regression using stata –xtreg– for income and –xttobit– for transfers, robust standard errors in brackets; *, **, *** for 10%, 5% and 1% significance levels

4.6. Conclusion

In this chapter we compare two approaches to measuring observable shocks: using self-reported natural disasters and using weather data shocks, which are constructed from

typhoon track and rainfall distribution. The self-reported number of disasters experienced by the household is free from justification bias and allows us to test the locus of control hypothesis in analysing perceived shocks. Two objectives have been achieved. First, we prove the presence of locus of control in the perception of no shocks. Using weather data shocks as the gold standard for validating perceived shocks, we find that households who diversify into non-farm activities tend to report no shocks despite their high exposure to weather shocks because they become less dependent on agriculture. Perceived shock therefore is strongly linked to the coping strategies available to rural households. Second, we compare the ability to capture the effect of shocks using perceived shocks and weather data shocks. Our exogenous measure of weather shocks positively predicts self-reported natural disasters with high significance and consistency. This positive relationship confirms the covariate nature of natural disasters. However, there is a large discrepancy between two records of shocks, which is correspondingly reflected in welfare analysis. This discrepancy further reflects the complementary weaknesses of two data sources. Weather data shocks are exogenous, but subject to spatial basis risk due to lack of accurate household locations. Perceived shocks correct for spatial basis risk, but are subject to self-reporting bias. In our sample, perceived shocks capture larger income losses and positive responses of public transfers, whereas weather data shocks capture smaller income losses and negative responses of public transfers. The tendency to report shocks is further confounded by the under-reporting bias due to old age and high frequency of weather shocks, and over-reporting bias due to health shocks. Our research therefore provides useful information for social studies on covariate weather data shocks in considering both advantages and disadvantages of using either perceived shocks or weather data shocks.

After analysing the determinants of shock perception, we verify that not reporting shocks is not always associated with better welfare. As the labour market in rural areas of Vietnam is under-developed, households that diversify away from agriculture can end up in low-skilled jobs with low income generation. Perceived shocks therefore do not always reflect lower welfare statuses, especially for households who remain in agriculture but achieve high productivity. This finding mirrors the view on non-farm diversification as a curative strategy when income from traditional activities is already falling. As noted by Meert et al. (2005) and shown later by Gautam and Andersen (2016), this strategy is only ‘optimally’ employed when labour characteristics such as household composition, age and especially education, are suitable. Our results highlight the important role played by non-farm diversification in rural areas and suggest further research into the situation in developing countries, especially in the context of weather shocks. If rural farmers do not perceive risks from weather shocks and thus are not likely to adopt suitable practices in response, and at the same time end up in low-end casual jobs when shocks happen, they will face extreme difficulty escaping poverty and coping with future income shocks.

Because perceived shocks are strongly linked to household characteristics we use weather data shocks instead of perceived natural disasters in subsequent analyses. The use of weather data shocks is subject to basis risk as analysed above. However, that basis risk is already minimised by using the smallest administrative level of commune to identify the scope of shock impact. As a result, we can take advantage of the bias-free characteristic of this shock measure.

CHAPTER 5

Asset versus Consumption Smoothing

5.1 Introduction

In this chapter we apply the Consumption Smoothing Theories and Asset Smoothing Theory described in Chapter 2 to analyse smoothing behaviours of poor rural households in Vietnam. We first review empirical evidence on this topic and relate the evidence to the context of Vietnam. We then propose a general framework to analyse the responses of farmers to different types of shocks. Using VARHS, we perform different theoretical tests and discuss the results before concluding the chapter.

5.2 Literature Review

The fact that shocks can “knock back” poor households and keep them from growing their way out of persistent poverty is a “real-world Sisyphean tragedy” (Carter & Barrett, 2006; Dercon, 1998; Krishna, 2010; McPeak & Barrett, 2001). Rural households characterised by low incomes and dependence on agriculture are especially vulnerable to income shocks (Alderman & Paxson, 1992; Günther & Harttgen, 2009; Jalan & Ravallion, 1999). A number of theories have been developed to explain how households respond to income shocks. The Permanent Income Hypothesis (PIH) predicts that households choose consumption based on a measure of long-term income termed permanent income (Friedman, 1957). Short-term fluctuations in income, namely transitory income, are smoothed by savings. PIH has been challenged for its failure to account for the excessive sensitivity of consumption (Hall, 1978). In response to this failure to predict household behaviour Cochrane (1991) and Mace (1991) developed the Complete Market Hypothesis (CMH), also known as Full Insurance Theory (Townsend, 1994). While PIH is concerned with the consumption choices of a household in isolation, CMH considers households within communities where shocks are classified as either idiosyncratic or covariate. Idiosyncratic shocks are household specific and are uncorrelated with shocks to other households in a

community. Covariate shocks affect a group of households in a community. CMH predicts that consumption is not insured against covariate shocks, but “all changes in idiosyncratic income, both permanent and transitory, are insured through current risk-sharing models” (Mace, 1991, p. 929). In her paper Mace includes income transfers between family members, informal and formal credit and insurance contracts as examples of risk-sharing mechanisms.

However, works on the joint test of CMH and PIH are limited due to several empirical challenges. On one hand, the statistical approach to PIH test allows for unobserved shock effects and therefore satisfactory distinction between permanent and transitory shocks (Blundell et al., 2008), but no possibility of distinguishing between covariate and idiosyncratic shocks. On the other hand, the use of observable shocks in joint tests of PIH and CMH - such as rainfall deviations - produces mixed results of both consumption smoothing (Jacoby & Skoufias, 1998) and no consumption smoothing (Dercon & Krishnan, 2000) against both idiosyncratic and covariate income shocks. A gap exists between the theoretical relation of two theories and the empirical test of this relation.

In less developed countries both PIH and CMH have been consistently rejected as explanations of household behaviours due to a lack of empirical evidence of consumption smoothing (Carter, 1997; Dercon & Krishnan, 2000; Dr'Eze & Sen, 1989; Fafchamps et al., 1998). Zimmerman and Carter (2003) proposed the asset smoothing theory (AST) as an alternative to consumption smoothing theories of PIH and CMH. This theory predicts that poor households smooth productive assets (such as livestock) rather than consumption. Households are predicted to behave differently near an asset bifurcation point, the *Micawber threshold*. When subjected to an income shock, households below the threshold accumulate assets and reduce consumption, and those above deplete assets to smooth consumption.

The development of AST is in effect an extension of the traditional models used in consumption smoothing theories. Instead of considering all assets as a buffer stock, AST distinguishes a group of productive assets that motivate households to smooth income by making more investments, even at the cost of reducing consumption (Zimmerman & Carter, 2003). The model includes the restriction of no access to credit with non-negative asset balances (Carter & Lybert, 2012, equation 5, p.257). Tests on AST have also been restricted to relatively homogeneous agricultural households, who have limited access to both credit and labour markets (Rosenzweig & Wolpin, 1993) and where farm profits are the only source of income and livestock the only productive assets (Carter & Lybbert, 2012; Carter & Barrett, 2006; Kazianga & Udry, 2006). Recent papers testing AST include more diverse productive assets (Zhou & Turvey, 2014), but are still subject to an imperfect risk-sharing constraint. However, informal credit is quite common in rural areas, notwithstanding gifts, transfers and other risk-sharing strategies (Fafchamps & Lund, 2003; Gerry & Li, 2010; Gertler & Gruber, 2002; Jacoby & Skoufias, 1998; Townsend, 1994). In addition, several papers have documented the existence of pluri-active agricultural households, who engage in non-farm business activities and off-farm employment to increase income (Barrett, Reardon, & Webb, 2001; Fuller, 1990). Those who participate in the labour market are less dependent on productive agricultural assets and are more likely to respond to shocks by increasing labour supply (Berloff & Modena, 2013; Blundell, Pistaferri, & Saporta-Eksten, 2016; Cameron & Worswick, 2003). Moreover, McPeak (2004) shows that assets are likely to be depleted to smooth consumption when income shocks occur, but smoothed in response to asset shocks. It is necessary therefore to provide for more rural heterogeneity in AST tests and distinguish between asset shocks and income shocks.

Vietnam is of particular interest for studies of poor household behaviours in relation to shocks. The country has experienced a rapid transition towards a market economy since the 1986 *Doi*

Moi. Evidence from the World Bank (2016) shows an expansion in financial markets including access to savings, credit and insurance in Vietnam. Investments in tractors and other productive assets have increased to substitute for labour which has increasingly shifted from agriculture to other sectors. However, restrictions remain in some markets, notably the land market which prevents households from readily adjusting their agricultural land holding. The farmers have and can lease land-use rights, but cannot sell land permanently because land is owned by the state. Rural areas, which account for 68 percent of the population, have benefited from market liberalization, but there is evidence that a subset of households is “left behind” by economic development with 18.6 percent of the population in rural areas below the poverty line.

The survey data described in Chapter 3 agree with the World Bank evidence. The income distribution given in Figure 5.1 shows that despite the strong growth of per capita income over the survey periods, a significant proportion of rural households remain below \$2/day (62% in 2006 and 14 % in 2012) the poverty line of \$2/day (62% in 2006 and 14 % in 2012). Further evidence of a poverty trap is provided by the outflow rates (Jarvis & Jenkins, 1998) presented in Table 5.1. This table shows that by 2012, 80 percent of households had total income above the poverty line compared to 70 percent in 2006. Of the 20 percent that remained in poverty in 2012, 74 percent started in the lowest four income deciles in 2006. Table 5.1 also indicates the high level of income mobility with 82.5 percent of households moving to higher or lower deciles between 2006 and 2012.

Table 5.1 Income mobility from 2006 and 2012

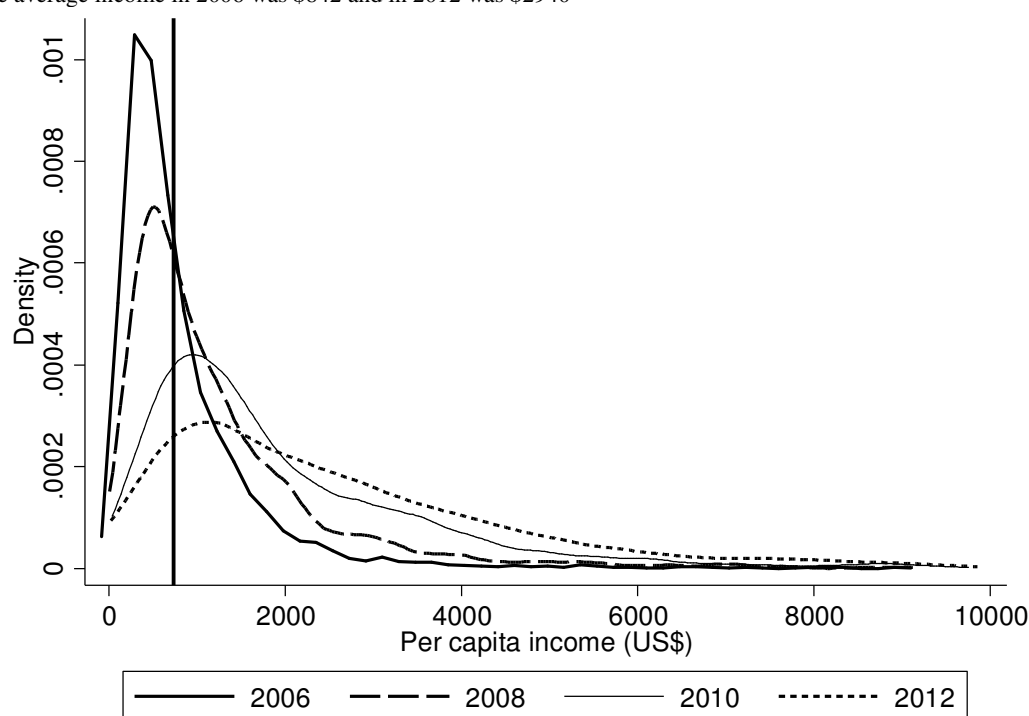
Per capita income decile 2006	Per capita income decile 2012										Total
	1	2	3	4	5	6	7	8	9	10	
1	22	18	14	15	7	13	4	4	4	1	100
2	18	17	18	10	13	5	8	5	3	3	100
3	14	16	16	12	15	7	7	5	7	1	100
4	13	14	13	12	15	7	8	10	5	3	100

5	5	10	8	14	13	17	11	8	6	7	100
6	7	7	11	13	8	12	14	14	7	7	100
7	6	4	9	9	14	15	7	11	17	9	100
8	6	6	5	6	7	10	16	17	14	12	100
9	5	4	4	6	4	7	13	15	17	25	100
10	4	3	3	3	5	7	12	11	19	32	100
Total	100	100	100	100	100	100	100	100	100	100	100

Note: Group 1 contains the poorest; group 10 the richest. Deciles calculated from the longitudinal sample, n=1,915.

In 2006 the \$2 a day poverty line for Vietnam fell in the 7th decile. In 2012 it fell in the 2nd decile.

The average income in 2006 was \$842 and in 2012 was \$2940



Note: The vertical line gives the \$2 per person per day poverty line as its annual equivalent value.
94 obs >10,000US\$ are excluded

Figure 5.1. Sample income distribution 2006-2012

Further indications of persistent poverty in Vietnam show that a significant proportion of households members suffer from some degree of malnutrition which may increase the prevalence of reduced labour input due to poor health: World Bank data for 2010 indicates that 23 percent of children under five years were malnourished. Indicators for education, another determinant of labour productivity are favourable: primary education enrolment (98%) and literacy rates of (90%) are relatively high by international standards.

In terms of household income shocks, Vietnam is a high risk country in terms of natural disasters and crop and animal disease. Rural areas are prone to a high and increasing frequency of typhoons and floods (Adger, Kelly, & Ninh, 2012; Thomas et al. 2010). In addition Vietnamese farm animals are prone to a set of highly contagious animal diseases including swine flu, avian flu and foot and mouth diseases. Vietnam therefore is suitable for analysing behaviours of rural households using the frameworks of CMH, PMH and AST. The findings will expand further current evidence on these theories as several assumptions are able to be relaxed. First, the rural households in Vietnam all spend time on agriculture but some households also participate in off-farm labour markets and have small scale non-agricultural businesses. Second, the households have access to food, labour and credit markets and benefit from local risk-sharing networks.

5.3 Theoretical Framework

This section presents a theoretical household model adapted from McPeak (2004) and Barret et al. (2008) where the household maximises expected utility over the current and all future periods. In the current period the farms assets are deterministic, but farm profit and labour availability may be subject to shocks. Assets are also subject to shocks at the end of the current production period. The theoretical model aims to capture household behaviours when shocks can affect the productivity of land, capital and labour differently. To this end household i at time t has productive assets k_{it} and allocates labour hours h_{it}^{agri} to farm work. The household is faced with a set of shocks that have a direct or indirect, idiosyncratic or covariate, income effect: covariate shocks are an agricultural income shocks $0 \leq CS_t^{income} \leq 1$ and productive asset shocks $0 \leq CS_t^{asset} \leq 1$; and labour shocks $0 \leq IS_t^{labour} \leq 1$ are idiosyncratic. In the empirical model CS_t^{asset} is due to animal disease and floods that damage productive assets, CS_t^{income} is due to crop disease and IS_t^{labour} due to a household health shock.

The household also participates in an off-farm labour market and earns $w_{it}(T_{it} - h_{it}^{agri})$ where w_{it} is the wage rate and T_{it} represents total working hours of household i . The household labour time constraint is binding and T_{it} allows for leisure time, although for simplicity the leisure decision is not explicitly represented here.

Agricultural income is given by a restricted farm profit function $\pi(p_{it}, w_{it}, k_{it})$ (Lau, 1976) where productive assets are treated as fixed. Agricultural labour input demand is given by Hotelling's lemma:

$$h_{it}^{agri} = h(p_{it}, w_{it}, k_{it}) = -\partial \pi(p_{it}, w_{it}, k_{it}) / \partial w_{it} \quad (5.1)$$

If the underlying production function is concave, the demand for labour is increasing in the fixed asset. Thus if an asset shock reduces capital, this also reduces the allocation of labour to agriculture and, due to the fixed time available for work, increases off-farm work.

The household maximises Bellman's equation

$$V(k_{it}) = \text{Maximum}[U(c_{it}) + \beta_i V(k_{it+1})] \quad (5.2)$$

Where $U(c_{it})$ is a strictly concave utility of consumption that satisfies the Inada conditions, β_i is a discount factor and the value function $V(k_{it+1})$ gives the future utility starting with a capital asset level and is strictly concave in the initial capital. The household is subject to a budget constraint:

$$c_{it} + I_{it} = \pi(k_{it}) + w_{it}(T_{it} - h_{it}^{agri}) + B(IS_t^{labour}, CS_t^{income}, CS_t^{asset}) \quad (5.3)$$

Where the budget is allocated to either consumption c_{it} or investment in productive assets I_{it} and is generated from agricultural profit and wages for off-farm labour given by the difference

between the total time available T_{it} and agricultural labour h_{it}^{agri} . The transfer function $B(IS_t^{labour}, CS_t^{income}, CS_t^{asset})$ represents a community or government response to shocks in terms of income transfers. Capital growth follows the equation:

$$k_{it+1} = k_{it}(1 - CS_t^{asset}) + I_{it} \quad (5.4)$$

To summarise the conditions on the functions, the utility and value function are strictly concave and differentiable. The restricted profit function is differentiable and convex in input and output prices and concave in the fixed input capital. The transfer function is assumed to be increasing with the shock level.

We derive comparative static results for the three shocks. For simplicity, we assume the asset shock to have a one-off effect on the capital stock, which affects future incomes, but not the current budget. Thus Bellman's equation becomes:

$$U(c) + \beta V[k(1 - CS^{asset}) + I] \quad (5.5)$$

The household subscript and time subscript are dropped to increase clarity. The comparative statics for the effects of the shock on investment is given by:

$$\frac{\partial I}{\partial CS^{asset}} = \frac{\beta k V''[k(1 - CS^{asset}) + I]}{U''(c) + \beta k V''[k(1 - CS^{asset}) + I]} \quad (5.6)$$

Assumptions about the strict concavity of the utility and Bellman's function indicate that investment is increasing with the size of the shock. On the same basis, consumption falls

$$\frac{\partial c}{\partial CS^{asset}} = - \frac{\beta k V''[k(1 - CS^{asset}) + I]}{U''(c) + \beta k V''[k(1 - CS^{asset}) + I]} \quad (5.7)$$

In response to the shock, the household increases investment and reduces consumption. A binding budget constraint would ensure that this is by an equal amount.

If an income shock affects agricultural income, the budget constraint becomes:

$$c + I = [\pi(k)(1 - CS^{income}) + w[T - h(p, w, k)]] \quad (5.8)$$

Investment and consumption fall:

$$\frac{\partial I}{\partial CS^{income}} = - \frac{TwU''(c)}{U''(c) + \beta V''(k+I)} \quad (5.9)$$

$$\frac{\partial c}{\partial CS^{income}} = - \frac{\pi(k) U''(c)}{U''(c) + \beta V''(k+I)} \quad (5.10)$$

If a labour shock occurs that reduces the hours available, the budget constraint is:

$$c + I = \pi(k) + w[T(1 - IS^{labour}) - h(k)] \quad (5.11)$$

Consumption and investment fall:

$$\frac{\partial I}{\partial IS^{labour}} = - \frac{TwU''(c)}{U''(c) + \beta V''(k+I)} \quad (5.12)$$

$$\frac{\partial c}{\partial IS^{labour}} = - \frac{\beta TwV''(k+I)}{U''(c) + \beta V''(k+I)} \quad (5.13)$$

If we relax the budget constraint so that household receives support from the community to insure against idiosyncratic shocks, the constraint becomes:

$$\pi(k) + w[T(1 - IS_t^{labour}) - h(k)] - c - I + B(IS_t^{labour}, CS) = 0 \quad (5.14)$$

where $B(IS_t^{labour}, CS) \geq 0$ represents the transfer function, which could be either public transfers, private transfers, or even credits, triggered when idiosyncratic shocks occur. With a transfer function, the comparative statics of an idiosyncratic shock are as follows. For investment we have:

$$\frac{\partial I}{\partial IS^{labour}} = \frac{[B'(IS_t^{labour}, CS) - Tw] U''(c)}{U''(c) + \beta V''(k+I)} \quad (5.15)$$

and for consumption:

$$\frac{\partial c}{\partial IS^{labour}} = \frac{\beta[B'(IS_t^{labour}, CS) - Tw] V''(k+l)}{U''(c) + \beta V''(k+l)} \quad (5.16)$$

In both cases the sign of the first-order conditions depend upon the sign of the term: $[B'(IS_t^{labour}, CS) - Tw]$. If this term is positive, then both investment and consumption increase because the transfer more than compensates the household's loss of income due to the labour shock. If this term is negative both investment and consumption are reduced.

In conclusion, AST behaviour is predicted when asset shocks occur as households reduce consumption and increases investment in productive assets. The effect of income shocks is similar to labour shocks in reducing both investments in productive assets and consumption. As labour in agriculture depends on current levels of productive assets, the effect consequently leads to reduced participation in agriculture and increased participation in the labour market. When an idiosyncratic shock is smoothed by community risk-pooling strategies, households maintain similar levels of productive assets and consumption as predicted by CMH.

5.4 Empirical Strategy

To test PIH⁴ and AST, we first decompose total income into permanent and transitory income by estimating:

$$y_{it} = (\beta_1 X_{it} + \gamma_{it}^{inc}) + \beta_2 CS_{v\{i \in I_v\}, t} + \beta_3 IS_{it} + \hat{y}_{it}^{res} \quad (5.17)$$

where y_{it} is log income, X_{it} is a vector of characteristics of household i in community v ; γ_{it}^{inc} is a household fixed effect; $CS_{\{i \in I_v\}, t}$ is a vector of discrete values of covariate shocks which are the number of shock incidents (flood, animal disease and crop disease) affecting community v at time t , a subset I_v gives the households living in community v , the term IS_{it} gives the value of the

⁴ We apply the quasi-experimental approach to PIH tests (Jappelli and Pistaferri, 2010), which has been increasingly used in developing economies due to the lack of longitudinal data (Paxon, 1992; Jacoby and Skoufias, 1998; Fafcham and Lund, 2003; Carter and Lybbert, 2012). This approach assumes that permanent income is determined by a vector of household characteristics and transitory income a vector of observable shocks.

idiosyncratic family health shocks that affect household i at time t ⁵. Using (5.17) income is decomposed into four components derived from fitted values: permanent income: $\hat{y}_{it}^p = \beta_1 X_{it} + \gamma_{it}^{inc}$; the income effect of covariate shocks: $\hat{y}_{it}^{CS} = \beta_2 CS_{v\{i \in i_v\}, t}$; the effect of idiosyncratic shocks: $\hat{y}_{it}^{IS} = \beta_3 IS_{it}$; and residual unexplained income \hat{y}_{it}^{res} .⁶

In all the following panel data models $\gamma_{it}^{labour}, \gamma_{it}^{PIH}, \gamma_{it}^{CMH}, \gamma_{it}^{AST1,2}$ are household fixed effects and $u_{it}^{labour}, u_{it}^{CMH}, u_{it}^{PIH}$ and $u_{it}^{AST1,2}$ are iid error terms. The consumption smoothing test for PIH is:

$$c_{it} = \phi_1 \hat{y}_{it}^p + \phi_2 \hat{y}_{it}^{CS} + \phi_3 \hat{y}_{it}^{IS} + \phi_4 \hat{y}_{it}^{res} + \gamma_{it}^{PIH} + u_{it}^{PIH} \quad (5.18)$$

where c_{it} is the log value of food consumption expenditure of household i in period t . PIH is supported if: $\phi_1 \approx 1$ and $\phi_2 = \phi_3 = \phi_4 = 0$. In other words, households adjust consumption according to a priori expectation of future incomes and smooth consumption against transitory income shocks⁷.

Previous studies that use PIH to test asset smoothing replace consumption with changes in asset balances ΔA_{it} (Carter & Lybbert, 2012; Jacoby & Skoufias, 1998; Kazianga & Udry, 2006; Paxson, 1992). We accordingly use the following specification to test AST.

$$\Delta A_{it} = \varphi_1 \hat{y}_{it}^p + \varphi_2 \hat{y}_{it}^{CS} + \varphi_3 \hat{y}_{it}^{IS} + \varphi_4 \hat{y}_{it}^{res} + \gamma_{it}^{AST1} + u_{it}^{AST1} \quad (5.19)$$

AST is supported if: $\varphi_2 = \varphi_3 = 0$.

⁵ A common concern with observable shocks is the effect of unobserved shocks. We limit this effect to the minimum by analysing four most common shocks to agricultural households in Vietnam. Except for crop diseases, other shocks are not reported by households to ensure a high level of exogeneity. Empirical result shows that income effects due to observed shocks are larger than unobserved income shocks.

⁶ There is an empirical issue as to whether shocks have a permanent or transitory effect on income. In this study we assume that all shocks have a transitory effect, although there is some evidence (not reported) that floods have an effect that extends beyond the current survey period.

⁷ The quasi-experimental approach will not capture other transitory and permanent effects of unobserved shocks, which are possible using the statistical approach (Blundell et al, 2008). However, use of observable shocks will allow the simultaneous test of CMH and the distinction between asset shocks and income shocks. The observed shocks are constructed so that unobserved shock effects are limited to the minimum possible.

Evidence for the CMH is assessed from the model:

$$\Delta \log c_{it} = \delta_0 + \delta_1 CS_{v\{i \in i_v\},t} + \delta_2 IS_{it} + \gamma_{it}^{CMH} + u_{it}^{CMH} \quad (5.20)$$

where $\Delta \log c_{it}$ represents the growth in food consumption of household i in period t . CMH is supported if $\delta_1 < 0$ and $\delta_2 = 0$.

In other words household food consumption is susceptible to covariate shocks that affect the community as a whole, but is smoothed against idiosyncratic shocks that can be self-insured or diversified away by community risk-sharing.

The relation between PIH and CMH is given by the comparison between (5.18) and (5.20). If we take the difference of (5.18), change in consumption reflects the changes in permanent income and income effects due to shocks. By definition and empirical construction, permanent income should (tend to) be temporally stable and have no effect on change in consumption. The income changes due to shocks are observed when shocks occur, and therefore are the effects of observable shocks. The strength of CMH versus PIH is evaluated by the evidence on consumption smoothing against idiosyncratic and covariate shocks⁸.

In addition to smoothing behaviours, we assess the labour response to shocks from:

$$h_{it}^{wage} = \alpha_0 + \alpha_1 CS_{v\{i \in i_v\},t} + \alpha_2 IS_{it} + \gamma_{it}^{labour} + u_{it}^{labour} \quad (5.21)$$

where h_t^{wage} is the proportion of total family labour hours spent working for wages off-farm.

⁸ Our approach has several advantages over Jacoby and Skoufias (1998). We focus on the scope of shocks rather than the anticipation of shocks to distinguish PIH from CMH, and consider income shocks to be transitory in accordance with the literature. However, if we follow Friedman (1957, p. 23) to define permanent income “to be whatever seems to correspond to consumer behaviour”, PIH and CMH are mutually supportive if covariate shocks are permanent, and idiosyncratic shocks transitory. In fact, the construction of floods by using extreme values of weather data makes this shock highly unanticipated. Without evidence on asset smoothing motivation proposed by AST, lack of consumption smoothing against this shock will support PIH.

5.5 Data

5.5.1 Survey

We use the data described in Chapter 3, section 3.2 for analysis.

5.5.2 *Measuring Covariate and Idiosyncratic Shock Variables*

To capture shocks, we use both independent and self-reported data. Floods are the most common natural disaster in Vietnam (EMDAT, 2017) and most are caused by typhoons (Imamura & Van To, 1997). From the records of typhoons (UNISYS, 2017), we track the movements of storm eyes and match those to the sampled communes up to 250km from the eye of the storm, the typical typhoon radius (Ahrens, 1991). We exclude cases where typhoons weaken and become tropical depressions, which are still likely to result in high rainfall levels. In that case, we adjust by the number of times when average monthly rainfall reaches extreme values. Rainfalls taken for 14 years from 30 provincial stations in Vietnam (MARD, 2017) are matched with the nearest commune (Figure 2.1).

Our approach is different from the use of rainfall deviation as a measure of shocks (see Paxson, 1992; Kazianga & Udry, 2006; Carter & Lybbert, 2012 for example). By using the extreme values of rainfalls and the incidents of typhoons, we are more likely to capture severe and unexpected shocks.

Similarly, we use the data on animal disease outbreaks from the OIE (2017) to match with affected communes within 10km, and construct a shock variable for the number of animal diseases outbreaks. Occurrences of floods and animal diseases are recorded for the 12 months prior to the survey date. This allows us to match income generated during the survey year to these

shocks. Floods and animal diseases are covariate shocks and are assumed to adversely affect all sample households within affected communes.

The VARHS also includes a self-reported question relating to whether the household has experienced an outbreak of crop disease within the previous two years. Although this variable is reported by households it is likely to affect all households in communities. To confirm this, a regression of the occurrence of crop disease on commune and year dummies explains 22% of the reported incidents, indicating that crop diseases are indeed a covariate shock.

The idiosyncratic shock variable is a measure of the health of all household members. We calculate the effects of illness on the household from the self-reported number of days when household members were unable to work normally.

5.5.3 Summary Statistics

Table 5.2 gives summary data for the three survey waves. Average income per capita for the survey households is \$2,171, similar to the reported figures by World Bank (Demombynes & Vu, 2015) and above the PPP line of \$2 per person per day. Food expenditure, which excludes own consumption, is \$4,914 per annum and accounts for 53 percent of income. Households, on average, have a relatively small land area of around 0.8 ha and associated with this land area is productive assets worth on average about \$2,000, although with a high level of variance. In our sample, productive assets include feed grinding machines, rice milling machines, harvesting machines, pesticide sprayers, tractors, ploughs, carts and cars. Households benefit from public transfers in the form of welfare payments and grants that account for 7 percent of income and private transfers that account for 8 percent. Average new credit accounts for 22 percent of income and is not included in total income.

The average occurrence of floods at 0.47 indicates that a flood occurs once every other year, and animal disease slightly more than one occurrence per year. This data is further evidence of how vulnerable Vietnam is to an increase in the frequency of typhoons and floods. Crop disease is less frequent with slightly more than a one in ten year frequency. Idiosyncratic health shocks are very rare, at only 3 percent of the family members on average.

Table 5.2. Summary statistics for household variables over in three survey waves

	Mean	Std.Dev
Income (\$)	9,174	14,002
Fortnight food consumption expenditure (\$)	189	164
No. of labour age members (17-60 yo)	2.85	1.40
No. of small children (<10 yo)	0.59	0.84
Head education (1-12)	6.68	3.57
HH size	4.45	1.72
Head age	52.28	12.97
Head gender (1=Male)	1.20	0.40
% of male member	0.49	0.19
Productive assets* (\$)	2,072	61,063
Agricultural land area (m ²)	7,796	14,050
Public transfer (\$)	603	1,893
Private transfer (\$)	707	2,428
Credit (\$)	2,034	9,373
Number of floods in the last year	0.47	0.99
Number of animal diseases in the last year	1.18	3.37
Crop diseases in the last 2 years(1=yes)	0.26	0.51
% of ill household members in the last year	0.03	0.06
No. of HHs/Obs		1,915/5,745

All households in the sample are involved in agriculture; however, there is variability among households. To account for this heterogeneity, we classify agricultural households into different labour allocation types corresponding to their major (>50%) allocation of total household labour time (Handbook, 2007, p. 294). *Agriculture* refers to crops and livestock activities on the family farm. *Wage* refers to both casual agricultural/non-agricultural work and salaried works. *Small businesses* refer to vendors and small shops. *Mixed* refers to the case where no occupation has a major labour allocation. We use the first wave 2006 as the baseline to categorise households (Table 5.3).

Analysis of labour allocation types shows that agricultural households are the majority (54%) followed by waged (24%), small business (15%) and mixed (6%). Table 3 lists characteristics that distinguish agricultural households from other groups. Despite having significantly larger

land area and ownership of productive assets (53%), agricultural households have a significantly lower income than households that allocate a larger proportion of labour time in waged employment ($p=0.015$) and business ($p=0.001$). However, they have higher access to transfers and credits, especially public transfers (50%). It is notable that agricultural households have higher income risks, but lower income spread than other group. Specifically, CoV for agricultural households in a same year is 1.12, much lower than that for waged (1.29) and business households (1.69). On the other hand, waged and mixed households have the lowest year-to-year CoV, at 0.63. Agricultural households have the highest year-to-year CoV at 0.68, which is close to the business group at 0.67.

Table 5.3 Characteristics of households by the four labour allocation household types

	Labour allocation type in 2006			
	Agriculture	Wage	Small business	Mixed
Income (\$)	7,973 (10,142)	9,767 (16,410)	12,078 (20,016)	10,287 (13,878)
Fortnight food consumption (\$)	171 (157)	209 (176)	214 (163)	208 (165)
Percent of households receiving:				
public transfers	50	40	31	34
private transfer	49	46	44	50
formal credit	39	34	31	42
Agricultural land area (m ²)	10,062 (15,794)	4,098 (7585)	4,223 (12,571)	4,605 (11,374)
No. of HHs	1,043	462	292	118

Note: Standard deviation given in parentheses.

5.6 Results

5.6.1 Determinants of Household Decisions

Table 5.4 presents the estimated version of (5.17), where log income is regressed against household characteristics to identify permanent income, transitory income and unexplained income components. Significant positive parameters related to permanent income include education, household members working, household head age and the area of agricultural land.

The number of young children (less than 10 years old) has a significant negative effect on total income, due to the call on household labour for child care.

Table 5.4 Total income regression used to decompose household income

Permanent income component	Log income	
	Coef.	(P-value)
HH size	0.179***	(0.000)
% of labour members	1.034***	(0.000)
% of small children	0.016	(0.915)
Head education	0.045***	(0.000)
Head age	0.096***	(0.000)
Head age squared	-0.001***	(0.000)
Head gender	-0.039	(0.731)
% of male member	0.160	(0.265)
Agricultural land area log	0.066***	(0.003)
<i>HH fixed effect included</i>		
Income effects due to shocks		
Floods	-0.047***	(0.000)
Animal diseases	0.022***	(0.000)
Crop diseases	-0.064***	(0.003)
Health shocks	-0.991***	(0.001)
R ²	0.73	
Obs.	5,745	

*** p<0.001; **p<0.05; *p<0.1 Robust Std.Error.

The positive coefficient on animal disease shocks appears anomalous and warrants further discussion. Animal disease shock events are largely related to swine flu, and incidences of this disease may temporarily increase income for the following reasons. First, agricultural households are likely to benefit from increases in meat prices due to supply scarcity (Tan, 2011). We find that households increase pig sales when there is an officially reported outbreak of swine flu in a commune. Second, households are possibly over-compensated due to mis-reporting infected pig numbers (Hennessy & Wolf, 2015). Decision no. 1442/QĐ-TTg issued in 2011 entitles households who have animals destroyed in infected areas by government officials to receive reimbursement of 70 percent or more of the market values. Newspaper reports have identified overcompensation of pig producers as an issue (Hung & Duy, 2008).

The PIH test is given in Table 5.5a (column 1) is the estimated version (5.18). The PIH equation regresses log household food consumption on income decomposed into permanent income and the income effects of shocks. The results offer little support for the PIH model as consumption is significantly and negatively affected by the income effects of floods and crop diseases. It should be noted that the income effects of floods and crop disease are negative and thus a positive parameter indicates a negative effect on consumption.

The AST test is given in Table 5.5a (Column 2). There is strong support for AST because none of the income effects of shocks are significant in changing balances of productive assets⁹. As crop diseases are income shocks and not asset shocks, the hypothesis that households deplete assets to smooth income shocks and smooth assets against asset shocks (McPeak, 2004) is rejected. Households are strongly driven to smooth incomes by investing in productive assets. This may be due to a need to purchase spray equipment when there is a crop disease outbreak. The results are similar to those of Carter and Lybbert (2012).

Table 5.5a Regression results for PIH and AST test

	Log food consumption-PIH test	Changes in asset balance
	(1)	(2)
Permanent income	0.712***(0.000)	121 (0.327)
Income effect due to floods	1.471***(0.000)	80 (0.38)
Income effect due to animal diseases	0.984***(0.000)	-43 (0.81)
Income effect due to crop diseases	1.588***(0.000)	-490 (0.267)
Income effect due to health shocks	-0.298 (0.204)	874 (0.264)
Unexplained income	0.464***(0.000)	4 (0.412)
Constant	-0.683 (0.204)	-1,311 (0.328)
	1,915	1,915
	0.64	0.01

Regressions are pooled OLS with household fixed effects. Two-tailed p-values in (.) are based on robust standard errors. *** p<0.001; **p<0.05; *p<0.1

⁹ A version of AST that uses the growth rates in productive assets balances leads to stronger AST support. For 1% of income losses caused by floods and crop diseases, productive asset grows significantly at the positive rates of 4% and 6% respectively.

Table 5.5b Regression results for CMH test

Food consumption growth-CMH test	
	(1)
Floods	-0.068*** (0.000)
Animal diseases	0.006* (0.099)
Crop diseases	-0.122*** (0.001)
Health shocks	-0.395 (0.233)
<i>HH characteristics included but not reported</i>	
Constant	0.353 (0.53)
No. of HH	1,915
R ²	0.14

Regressions are pooled OLS with household fixed effects. Two-tailed p-values in (.) are based on robust standard errors. *** p<0.001; **p<0.05; *p<0.1

The dependent variables in Table 5.5b are those in Table 5.5a transformed to their time differences in natural logs. As such, they can be interpreted as continuous growth rates. The CMH test is given in Table 5b column 1 and is the estimated version of (5.20). Consumption growth is significantly and negatively affected by the occurrence of the covariate shocks: floods and crop diseases. The effect of idiosyncratic health shocks is insignificant, and increase in income due to animal diseases is slightly positive. These results support the CMH as consumption growth is reduced by the occurrence of covariate shocks, and insured against that of idiosyncratic health shock.

5.6.2 Home Produced Food Consumption and Labour Reallocation Strategies

In other papers, there has been an emphasis on consuming grain produced on the household's farm as an alternative to selling livestock (Carter & Lybbert, 2012; Kazianga & Udry, 2006). Table 5.6 column 1 presents regression results for the growth in value of household consumption of home produced food against occurrence of shocks. The results show that consuming home-produced food responds positively to the occurrence of floods and crop diseases. The reduced self-consumption when animal diseases occur is of home produced

livestock, which is understandable. Table 6 column 2 gives results for the regression of log consumption on permanent income and the income effects of shocks derived from the model presented in Table 4. In common with the results for the regression for consumption growth, the negative income effects of floods and crop disease both increase consumption of home -produced food. Appendix 1 gives further regression tables on the types of food consumed.

Table 5.6 Regression results for the consumption of home production

	Growth of consumption of home production	Log consumption of home production
	(1)	(2)
Occurrence of:		
Floods	0.130*** (0.009)	
Animal diseases	-0.049*** (0.001)	
Crop diseases	0.332*** (0.000)	
Health shocks	-1.102 (0.21)	
<i>HH characteristics included but not reported</i>		
Constant	-1.529 (0.317)	
Permanent income		0.391*** (0.001)
Income effects due to		
Floods		-1.448** (0.027)
Animal diseases		-0.701 (0.106)
Crop diseases		-4.883*** (0.000)
Health shocks		0.918 (0.114)
Unexplained income		0.156*** (0.000)
Constant		-4.281*** (0.001)
No. of HH	1,915	1,915
R ²	0.12	0.66

Regressions are pooled OLS with household fixed effect. Two-tailed p-values in (.) are based on robust standard errors*** p<0.001; **p<0.05; *p<0.1

Table 5.7 presents the results of a regression of the proportion of household labour time allocated to waged labour in response to shocks, lagged shocks and other socioeconomic variables. Participation in waged labour responds expectedly to household size and composition and to the age of the household head. Thus larger households with more labour aged members and younger household heads are likely to spend more time on waged labour. Shocks reduce labour market participation in the year of floods occurrence, possibly due to rebuilding and clean-up activities on the home farm and the fall in labour demand within the commune at the time of the flood. The

statistical insignificance of lagged floods and other shocks might be the result of endogeneity in the specification. Exposure to shocks leads the households to diversify into non-farm activities, which in turn makes them less vulnerable to shocks in the next production period. This problem has been mitigated by use of exogenously measured shocks of floods and animal diseases, but has not been resolved completely. We are not aware of any other feasible solutions in the literature for this problem.

Table 5.7 Response of labour allocation to shocks

Percent of wage-related activities in total labour days	
Floods	-0.027*** (0.000)
Lagged floods	0.003 (0.85)
Animal diseases	0.001 (0.456)
Lagged animal diseases	-0.001 (0.436)
Crop diseases	0.01 (0.401)
Lagged crop diseases	-0.01 (0.346)
Health shocks	-0.213 (0.124)
Lagged health shocks	0.234 (0.113)
HH size	0.057*** (0.000)
% of labour members	0.168*** (0.001)
% of small children	-0.02 (0.785)
Head education	-0.003 (0.483)
Head age	-0.012*** (0.008)
Head age ²	0.0001*** (0.001)
Head gender	0.063 (0.145)
% of male member	0.22*** (0.001)
Agricultural land area log	-0.019* (0.096)
Constant	0.563* (0.065)
No. of HH	1,915
R ²	0.77

Regressions are pooled OLS with household fixed effect. Two-tailed p-values in (.) are based on robust standard errors. *** p<0.001; **p<0.05; *p<0.1

5.6.3 Effectiveness of Public and Private Risk-sharing

Table 5.8 shows the results for a Tobit regression showing the responsiveness of public, private transfer and credit to the income effects of shocks. As can be seen from Table 5.8 (column 1) public transfers increases in response to the income effects of all shocks except floods. The significant reduction in public transfers in the event of floods may be due to other costs incurred

on regional authorities during floods (Fafchamps, 2003, p. 54). Similarly, private transfers are reduced by an even larger extent than public transfers when floods occur. This may be explained by the fact that if private transfers depend on the local community, and most households are adversely affected by flood, this will tend to reduce transfers to other households. New credit (column 3) responds positively to crop disease probably due to supplier credit for pesticides. The negative effect on animal disease (note that there is positive income effect for animal disease) might be explained by a reduction in the households' collateral to secure loans.

Table 5.8 Regression results for transfer functions

	Risk-sharing strategy		
	Public transfer	Private transfer	New loans
	(1)	(2)	(3)
Permanent income	-5,197***(0)	-1,962***(0)	30,381***(0)
Income effect due to floods	18,468***(0)	68,541***(0)	-19,594 (0.45)
Income effect due to animal diseases	-10,032**(0.02)	733 (0.888)	-76,585***(0.001)
Income effect due to crop diseases	-13,413**(0.041)	8,905 (0.36)	-140,409***(0.003)
Income effect due to health shocks	-17,169***(0)	-19,618***(0)	-46,790 (0.163)
Unexplained income	-198 (0.7)	1,740***(0.005)	889 (0.747)
Constant	47,400***(0)	14,866***(0)	-369,197***(0)
No. of HH	1,915	1,915	1,915
Pseudo R	0.0058	0.0022	0.0051

Tobit regression with lower limit of 0. Two-tailed p-values in (.) are based on robust standard errors.

5.6.4 Heterogeneity in Household Responses

This section explores the heterogeneity of households along two dimensions, first in terms of their labour allocation strategy between agriculture, waged employment and business and second, we explore the role of variability in education and productive assets in terms of consumption smoothing. Table 5.9 shows that asset smoothing at the expense of consumption smoothing is strongest in agricultural households. Only agricultural households, out of the four household types (Agriculture, Wage, Business and Mixed), significantly increase their investment in productive assets when income is reduced by crop diseases and floods (column 3). The severe effect of floods is further confirmed by the reduced food consumption of all groups based on both CMH test (column 2) and PIH test (column 4). Business households have the highest level of

consumption insurance relative to health shocks: they have a near unit elasticity for the income effect of health shocks (column 4).

Table 5.9 Theory testing and risk-sharing evaluation for different labour allocation types

	Household type	Log income (1)	Changes in asset balances (2)	Log food consumption (3)	Food consumption growth (4)
Floods	<i>Agriculture</i>	-0.08*** (0.00)			-0.06** (0.02)
	<i>Wage</i>	-0.01 (0.44)			-0.05* (0.08)
	<i>Business</i>	-0.03 (0.32)			-0.08** (0.02)
	<i>Mixed</i>	-0.04 (0.16)			-0.17*** (0.01)
Animal disease	<i>Agriculture</i>	0.02*** (0.00)			0.01 (0.43)
	<i>Wage</i>	0.02*** (0.00)			0.01 (0.20)
	<i>Business</i>	0.02** (0.01)			0.003 (0.75)
	<i>Mixed</i>	0.05*** (0.00)			0.004 (0.86)
Crop disease	<i>Agriculture</i>	-0.10*** (0.00)			-0.14*** (0.00)
	<i>Wage</i>	0.01 (0.90)			-0.16* (0.06)
	<i>Business</i>	0.03 (0.71)			0.01 (0.92)
	<i>Mixed</i>	0.04 (0.70)			0.03 (0.79)
Health shock	<i>Agriculture</i>	-1.78*** (0.00)			-0.78 (0.12)
	<i>Wage</i>	-0.39 (0.43)			-0.86 (0.19)
	<i>Business</i>	-0.49 (0.47)			0.65 (0.30)
	<i>Mixed</i>	1.15 (0.27)			0.73 (0.66)
	Constant	5.20*** (0.00)			-0.90 (0.26)
<i>Household characteristics included but not reported</i>					
Permanent Income	<i>Agriculture</i>		1.00 (0.81)	0.81*** (0.00)	
	<i>Wage</i>		9.56 (0.18)	0.65*** (0.00)	
	<i>Business</i>		760.76 (0.31)	0.46*** (0.00)	
	<i>Mixed</i>		-14.66* (0.11)	0.79*** (0.00)	
Flood income effect	<i>Agriculture</i>		89.01 (0.17)	1.41*** (0.00)	
	<i>Wage</i>		61.61 (0.35)	1.57*** (0.00)	
	<i>Business</i>		-201.79 (0.72)	0.92** (0.02)	
	<i>Mixed</i>		64.76 (0.11)	2.24*** (0.00)	
Animal disease income effect	<i>Agriculture</i>		-127.20 (0.21)	0.86*** (0.00)	
	<i>Wage</i>		17.47 (0.35)	1.20*** (0.00)	
	<i>Business</i>		312.83 (0.75)	0.86*** (0.00)	
	<i>Mixed</i>		-49.66 (0.16)	0.46 (0.49)	
Crop disease income effect	<i>Agriculture</i>		-6.17 (0.65)	1.75*** (0.00)	
	<i>Wage</i>		23.00 (0.60)	1.88** (0.01)	
	<i>Business</i>		-4160.92 (0.24)	-0.29 (0.76)	
	<i>Mixed</i>		11.75 (0.62)	0.46 (0.69)	
Health shocks effect	<i>Agriculture</i>		23.28 (0.25)	-0.10 (0.79)	
	<i>Wage</i>		-2.61 (0.74)	0.13 (0.73)	
	<i>Business</i>		3,726.81 (0.25)	-1.04** (0.02)	
	<i>Mixed</i>		3.512 (0.81)	-0.78 (0.45)	
Unexplained Income	<i>Agriculture</i>		7.544 (0.26)	0.48*** (0.00)	
	<i>Wage</i>		4.461 (0.22)	0.46*** (0.00)	
	<i>Business</i>		-31.50 (0.46)	0.41*** (0.00)	
	<i>Mixed</i>		-1.24 (0.60)	0.53*** (0.00)	
	Constant		-105.16 (0.18)	-0.001 (0.10)	
No. of HH	No. of HH	1,915	1,915	1,915	1,915
R ²	R ²	0.73	0.05	0.64	0.14

Regressions are pooled OLS with household fixed effect. *** p<0.001; **p<0.05; *p<0.1
Two-tailed p-values in parenthesis are based on robust standard errors.

As a further test of behavioural consistency, we follow Carter and Lybbert (2012) by applying Hansen's (2000) threshold estimator to assess if there is a bifurcation point (Micawber threshold) in the sample. In addition to productive assets in 2006, we use head education in 2006 as a proxy for labour skills to identify the bifurcation in smoothing behaviours. We found no change in smoothing behaviours of agricultural household compared to results in Table 5a. We therefore present results for those who diversify away from agricultural activities (wage, business and mixed groups) in Table 5.10. As can be seen, the presence of labour market leads to more diversified household behaviours. Specifically, we find that rural households who diversify their income activities by participating in the labour market successfully smooth consumption against the production shocks. However, they fail to smooth consumption against the labour market shock. On the contrary, those who depend more on agriculture fail to smooth consumption against the production shock, but manage to smooth consumption against the labour market shocks. In our sample, the households with productive assets over 0.467 mil VND are those who still depend on agriculture. They spend most of their time on agriculture (on average 36% of total labour days) but diversify into labour (34%) and small business activities (28%) as well. They appear to benefit from this diversification by winning the highest income levels (84mil VND) and tend to reside most in Ha Noi (Red River Delta) and Long An (Mekong River Delta) – two major rice producing deltas in Vietnam. Their high incomes and possibly locations make them less vulnerable to floods. The high dependence on crops makes them vulnerable to crop diseases but not to animal diseases. The households with productive assets less than or equal to 0.467 mil VND are further divided into those with more than one year of schooling, and those with less. The household with limited

productive assets (≤ 0.467 mil VND) but equipped with basic labour skills (>1 year of schooling) are those who depend on the labour market for their livelihood. They spend on average 46 percent of labour time on wage-related activities and only 29 percent of labour time on agriculture activities. They also present the majority of the proportion with negligible productive assets and therefore are likely to engage in raising livestock for their agricultural activities. Participation in the labour market leads them to depend less on agriculture and to manage to smooth consumption against crop diseases but not against animal diseases. However, their monthly wages are low, between 1.5-3 mil VND and the skills are basic as most are builders and workers for other farms. Their average income is much lower than the group above (46 mil VND). Therefore they suffer severely from the reduced labour demand when floods occur. The final group of households have limited productive assets (≤ 0.467 mil VND) and limited labour skills (≤ 1 year of schooling). They represent the group of households whose incomes are trapped in a low equilibrium (26 mil VND) and thus consumption cannot be lower. This minority group relies most on transfers for their subsistence in addition to doing small amounts of casual work. It is noted that for both groups of households above and below the asset threshold, asset smoothing behaviours are prevalent. The results are the same when we exclude households without the initial productive assets.

Table 5.10 Threshold testing PIH consumption smoothing for asset value and education
Log food consumption-PIH test

	Pro>0.467 mil VND	Pro≤0.467 mil VND and Edu>1	Pro≤ 0.467 mil VND and Edu≤1
Permanent income	0.607*** (0.000)	0.587*** (0.000)	0.63** (0.012)
Income effect due to floods	0.197 (0.808)	1.789*** (0.000)	0.07 (0.948)
Income effect due to animal diseases	0.296 (0.718)	1.17*** (0.000)	-0.201 (0.859)
Income effect due to crop diseases	3.337** (0.011)	0.282 (0.643)	0.432 (0.825)
Income effect due to health shocks	0.185 (0.865)	-0.339 (0.431)	-0.868* (0.073)
Unexplained income	0.327*** (0.000)	0.459*** (0.000)	0.704*** (0.000)
Constant	0.751 (0.664)	0.69 (0.383)	0.271 (0.915)
No of HHs	155	669	48
R ²	0.53	0.65	0.68

Edu: no. of schooling years of household head in 2006; Pro: balance of productive assets in 2006. Regressions are pooled OLS with household fixed effect. Two-tailed p-values in parenthesis are based on robust standard errors. *** p<0.001; **p<0.05; *p<0.1

5.7 Conclusion

The households in the survey exemplify how resilient farm households can be in terms of maintaining income growth when subjected to frequent and serious shocks. It also shows how complex risk - coping strategies are in a developing market economy where households can reallocate labour away from agriculture to other sectors.

The evidence of the three theoretical models is mixed. The PIH is rejected as households cannot smooth consumption against the assumed transitory income effects of shocks. CMH is accepted because households can insure consumption against idiosyncratic health shocks largely by public and private transfers, but not against covariate shocks. There is support for AST, but the asset threshold is negligible because the presence of the labour market enables households to diversify their activities away from agriculture and therefore depends less on productive assets. An issue with the labour market is that participation is affected by floods. This would imply that the waged jobs are relatively low-skilled and linked to the fortunes of agriculture. Therefore waged

employment is not always risk reducing. In addition we find those with productive assets above the threshold continue to smooth assets because of their high reliance on agriculture. Compared to the result of Carter and Lybbert (2012), our sampled households therefore represent those motivated to change their livelihood equilibriums to better situations. We do find a sample of households who are not motivated to destabilise consumption to smooth assets. These households are trapped in the lowest income levels because of limited labour skills and negligible productive assets. Concerns about the vulnerability of households remain. In 2012, 20 percent of households remained below the poverty line and there is evidence from Table 1 that households can be downwardly mobile possibly due to shocks. Covariate shocks, especially floods remain an issue as there appears to be a significant reduction in government support (local and national) when floods occur in a commune. This would appear to represent a market failure as communes are unable to self-insure against floods and there appears to be no formal or informal insurance against floods. In contrast insurance mechanisms through government slaughtering programs and producer compensation work well for animal disease, although possibly too well, as there is evidence of over-compensation.

Despite the lack of flood insurance, these households continue in aggregate to increase income and consumption by actively accumulating productive assets and improving education for better labour skills. In the future the development process may be accelerated by access to flood insurance that could help household rebuild after floods, and the development of labour markets that are not linked to the agricultural sector in rural regions. However, in designing a suitable policy, it is necessary to further consider the effects that income shocks may have on the risk preferences of the affected households. The next two chapters undertake a comprehensive study of this topic.

CHAPTER 6

Review on the Relation between Risk Preferences and Income Shocks

6.1 Introduction

The theoretical analysis of decision making under uncertainty has adopted both normative and positive approaches. Normative models have been largely based on linear functional forms while positive models allow for more flexible functional forms. The aim of this review is to provide a brief comparison of different theoretical models and the empirical evidence on the uses of these theories in explaining risk behaviours after an experience of income shocks. The next section reviews the main theories of decision making under uncertainty. Section 6.3 discusses the various approaches to measuring risk preferences which represent the theories reviewed in section 6.2. Section 6.4 describes the estimation methods. Section 6.5 reviews the theoretical and empirical evidence on the stability of risk preference and the literature that uses natural disasters to explain the instability of risk preferences. Section 6.6 summarises the main issues reviewed in this chapter.

6.2 Theoretical Foundation

6.2.1 Normative Theories

Expected value theory (EVT) and Expected Utility Theory (EUT) both assume linear probability. While EVT assumes a linear value function, EUT allows linearity (risk-neutral agent), concavity (risk-averse agent) or convexity (risk-loving agent) of the value function. EUT is collapsed to EVT when people are risk-neutral. Kahneman and Tversky (1979) summarised three important tenets of EUT:

- (i) Expectation: The overall utility is weighted by the probability of each state. This is also known as the *independence axiom*.
- (ii) Asset integration: The overall utility is the final state, after integrating one's assets with states

- (iii) Risk aversion: A person is risk averse if he prefers the certain state to any risky combination of different states with the same expected value.

The third characteristic is associated with a concave utility function. Therefore, it can be said that decreasing marginal utility is associated with risk aversion. EUT was subsequently developed to include three models. The first model is the Expected Utility of Terminal Wealth model (Arrow, 1965; Pratt, 1964). This model assumes that risk preferences are defined over the terminal wealth, which is the combination of the lottery's payoff and the current wealth of the decision maker (DM). This model is used to derive the Arrow-Pratt risk aversion measure. The second model is the Expected Utility of Income Model, which assumes that risk preferences are independent of wealth. The third is the combined Expected Utility of initial wealth and income model (Cox & Sadiraj, 2006) which allows full to no asset integration.

6.2.2 Descriptive Theories

The development of descriptive approach is based on observation of behaviours that violate the EUT axioms. First is the St. Petersburg paradox. Bernoulli (1738) showed that according to EVT, the value of a lottery that pays 2^k when a fair coin comes up heads for the first time on flip k is $\sum_{k=1}^{\infty} 2^k \times (\frac{1}{2^k})$. However, individuals are only willing to pay small finite amounts to play this lottery. Bernoulli (1738) proposed a log utility function to arrive at a finite value for the lottery. However, changing value function does not solve the problem because it is the probability function that matters. For example, a modified version of St. Petersburg paradox, a lottery that pays e^{2^k} when a fair coin comes up heads for the first time on flip k , can again lead to infinite expected value.

Second is the Allais paradox (Allais, 1953) in Figure 6.1

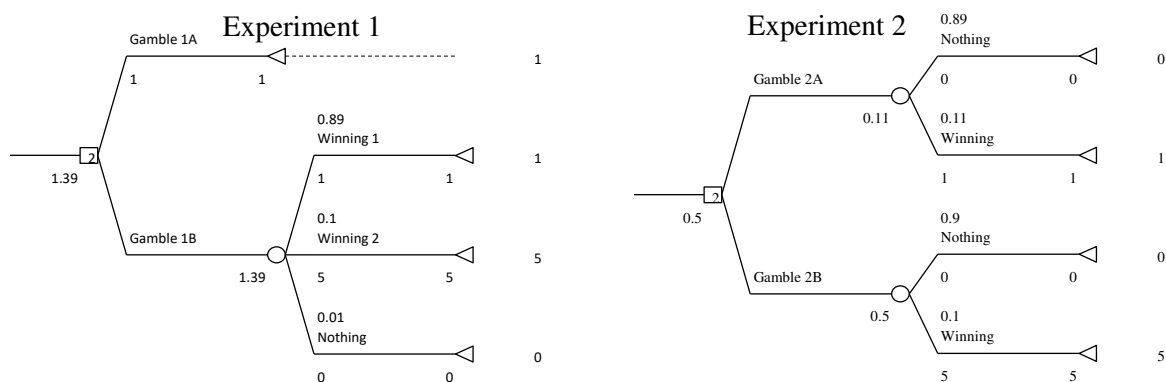


Figure 6.1 Illustration of Allais paradox

An EUT maximizer will choose gamble 1B and 2B in two experiments because of higher expected pay-off. Allais (1953) showed that according to EUT, a person who chooses 1A should choose 2A in panel A because of the independence axiom. From experiment 1, we have the following identity for a DM that chooses gamble 1A: $0.89U(1) + 0.11U(1) > 0.89U(1) + 0.1U(5) + 0.01U(0)$. Because of the independence axiom, we have $0.11U(1) > 0.1U(5) + 0.01U(0)$, which is equivalent to $0.89U(0) + 0.11U(1) > 0.89U(0) + 0.1U(5) + 0.01U(0)$ so the DM will choose gamble 2A. However, the majority choose 1A and 2B. This effect was labelled by Kahneman and Tversky (1979) as the *certainty effect* to account for the fact that people overweight outcomes that are considered certain, relative to outcomes that are considered probable. Many alternative theories thus have been developed, which can be categorised into reference-dependent theory (Prospect Theory, Salience Theory, Regret Theory) and non-reference theories (Rank-Dependent theory, Weighted Theory). Table 6.2 provides a summary of major theories of decision under uncertainty and how departures from the normative approach to descriptive approach are developed.

Table 6.1: Brief comparison of different theories of choice under uncertainty

Theory	Probability function	Proposed by
Expected Value Theory	$U_{EV}(\{Y_n, P_n\}) = a + b \sum_{j=1}^n p_j y_j, b > 0$	Bernoulli (1738)
Expected Utility Theory	$U_{EU}(\{Y_n, P_n\}) = \sum_{j=1}^n p_j u(y_j, w)$	Von Neumann and Morgenstern (1947)
Dual theory of EU	$U_{DU}(\{Y_n, P_n\}) = \sum_{j=1}^n [f(\sum_{k=j}^n p_k) - f(\sum_{k=j+1}^n p_k)] y_i$	Yaari (1987)
Rank-dependent theory	$U_{RD}(\{Y_n, P_n\}) = \sum_{j=1}^n \left[q\left(\sum_{k=1}^j p_k\right) - q\left(\sum_{k=1}^{j-1} p_k\right) \right] u(y_i, w)$	Quiggin (1982)
Cumulative prospect theory	$U_{CP}(\{Y_n, P_n\})$ $= \sum_{j=1}^{N_r} \left[w^- \left(\sum_{k=1}^j p_k \right) - w^- \left(\sum_{k=1}^{j-1} p_k \right) \right] v^-(y_i - r)$ $+ \sum_{j=N_r+1}^n \left[w^+ \left(\sum_{k=j}^n p_k \right) - w^+ \left(\sum_{k=j+1}^n p_k \right) \right] v^+(y_i - r)$	Tversky and Kahneman (1992)
Weighted Utility	$U_{WD}(\{Y_n, P_n\}) = \frac{\sum_{j=1}^n W p_j u(y_j, w)}{\sum_{j=1}^n W p_j}$	Hong (1983)
Salience Theory	$U_{ST}(\{Y_n, P_n\}) = \sum d^+ u(y_i, w r) + \sum d^- u(y_i, w r)$	Bordalo, Gennaioli, and Shleifer (2012)
Regret Theory	$U_{ST}(\{Y_n, P_n\}) = \sum_n p_s M(y_i)$	Loomes and Sugden (1982)

Source: (Cox & Sadiraj, 2008) - reproduced

A lottery $\{Y_n, P_n\}$ pays amount of money $Y_n = [y_n, y_{n-1}, \dots, y_1]$ with respective probabilities $P_n = [p_n, p_{n-1}, \dots, p_1]$, with $n \in N$, $\sum_{j=1}^n p_j = 1$; w is the agent's initial wealth; q is the probability function in rank-dependent theory; W is the weighting function in weighted utility theory; v^- and v^+ are value functions for loss and gain respectively in Cumulative Prospect Theory (CPT); w^- and w^+ are weighting functions for loss and gain respectively in CPT; d^- and d^+ are the gain and loss decision weights, r is the reference point in salience theory and CPT; $M(y_i)$ is the utility of consequences in regret theory

Kahneman and Tversky (1979) introduced Prospect Theory (PT) to violate all three tenets of EUT, namely inconsistencies, intransitivities and violation of dominance. According to PT *“carriers of value are changes in wealth or welfare, rather than final states”* (Kahneman & Tversky, 1979, p. 277). The value function for changes of wealth is concave above the reference point, and convex below it, therefore losses loom larger than gains. Another parameter of risk preference, “loss aversion”, is added to account for the steeper utility in the loss domain. Loss aversion is a discontinuity in the slope of the value function at the payoff equal to the reference payoff. Kahneman and Tversky (1979) proposed that weighting function is different in the loss domain compared to the gain domain. The weighting function of PT is in effect the ratio of the weight associated with the probability p to the weight associated with the certain event. One marked difference is that very low probabilities are generally over-weighted, but the sum of weighting function of all probabilities is smaller than 1.

Quiggin (1982) introduced Rank-Dependent Utility (RDU) characterised by the probability weighting function with subjective evaluation of prospects. If the probability weighting function is convex, the weight attached to the worst outcome is higher than the weight attached to the best outcome, resulting in a pessimistic “probabilistic risk” attitude. Tversky and Kahneman (1992) incorporated RDU into PT and proposed cumulative prospect theory (CPT), which is a combined function of probability and value with a two-part power utility function and a two-part probability weighting function corresponding to the gain and loss domains.

Similar to PT, Regret Theory (Loomes & Sugden, 1982) transforms the utility function into utility of consequences and introduces the concept of “regret aversion”, which means that

what you get from a chosen action and an alternative action give rise to disproportionately large regrets. The comparison of the outcomes within a given prospect leads to a possibility of disappointment when the outcome of a gamble compares unfavourably with what they might have had. Salience theory proposed by Bordalo et al. (2012) also defines the consequences with regard to a reference point and assigns different weights for losses and gains.

EUT represents the normative approach and has dominated literature on decision making under uncertainty. Therefore the theories developed under the descriptive approach are also often referred to as Non-EUT. Prospect Theory proposed by Kahneman and Tversky (1979) is the most dominant non-EUT.

6.3 Measuring Risk Preferences

EUT is characterised by only one parameter of risk aversion. Development of non-EUT leads to the development of other parameters of risk preference. In this section, we focus on the comparison between EUT and PT.

6.3.1. Measuring Risk Preferences using EUT

6.3.1.1. Risk Aversion

Risk aversion is the earliest known and the key parameter of risk preference. As mentioned before, risk aversion was originally defined in the EUT framework (Arrow, 1965; Pratt, 1964) in the Terminal Wealth model. Absolute risk aversion (ARA) is

$$ARA(x) = -\frac{U''(x)}{U'(x)} = -\frac{d}{dx} \ln(U'(x)) \quad (6.1)$$

As can be seen ARA depends on the level of wealth measured x . To enable comparability and independence of wealth, relative risk aversion (RRA) is defined as:

$$RRA(x) = -\frac{x \cdot U''(x)}{U'(x)} = -x \frac{d}{dx} \ln(U'(x)) \quad (6.2)$$

The concept of risk aversion is closely related to the decreasing marginal utility feature of utility function as illustrated in Figure 6.2.

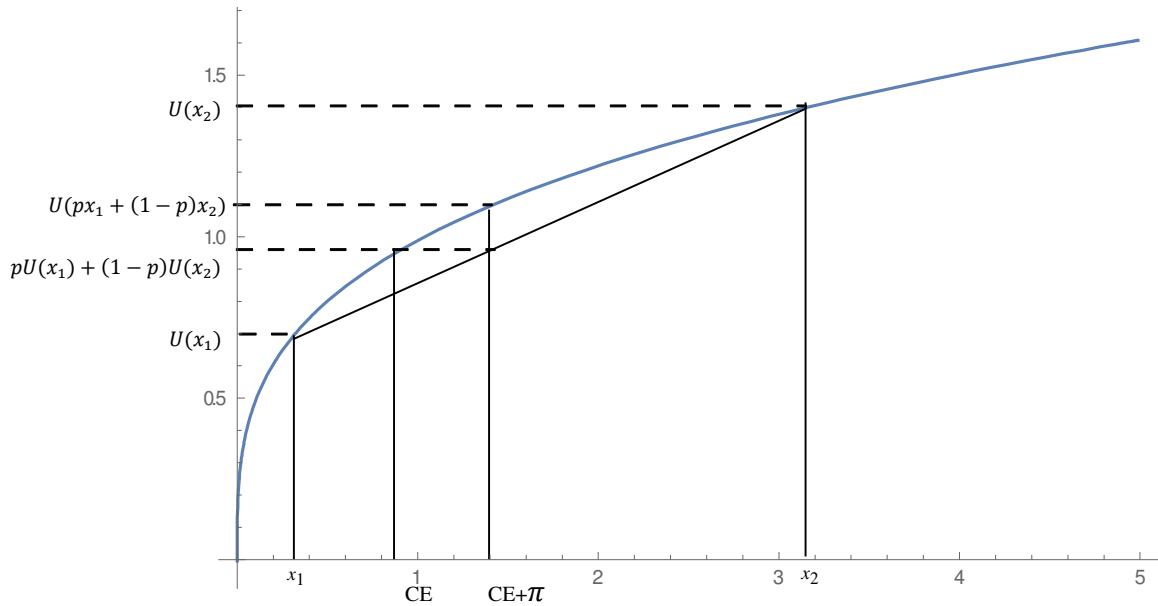


Figure 6.2: Illustration of risk aversion measure

In Figure 6.2 the utility function is concave with decreasing marginal utility function. In this case, the person is risk averse because a linear combination of utilities of two states x_1 and x_2 weighted by the probability of each state is smaller than the utility of the weighted probability of two states: $E[U(x)] < U(E[x])$. The person is risk neutral if the utility function is linear: $E[U(x)] = U(E[x])$ and risk seeking if the utility function is convex: $E[U(x)] > U(E[x])$. Risk premium π is the certain payment that leaves the decision maker indifferent between the gamble and the risk-free outcome, or the certainty equivalent (CE). Another less common measure of risk aversion is partial risk aversion, which is based on the specification of dividing the measured wealth x into the certain component x' and the uncertain component x'' . Partial risk aversion (PRA) is then defined as:

$$PRA(x) = -x'' \frac{U''(x)}{U'(x)} \quad (6.3)$$

PRA is related to RRA by the following equation:

$$PRA(x) = \frac{x''}{x} RRA(x) \quad (6.4)$$

As can be seen, PRA is proportional to RRA and the factor of proportionality equals the fraction of total wealth that is subject to risk (Binswanger, 1980).

6.3.1.2. Risk Aversion and Wealth

The way risk aversion is defined makes it in effect a measure of the curvature of the utility function. The more concave the utility function, the higher the risk aversion is. In other words, the faster the marginal utility decreases, the higher the risk aversion is.

Many assumptions are made about the relationship between risk aversion and wealth, and thus many utility functions are assumed. Arrow (1965, 1971) and Pratt (1964) proposed the constant absolute (CARA) and constant relative (CRRA) risk aversion forms. Merton (1971) proposed the hyperbolic absolute risk averse (HARA) form that can accommodate a wide range of risk preferences, either in CARA or CRRA forms. Voluminous works on developing this flexibility feature has been conducted. Examples are the expo-power (EP) form by Saha (1993), the power risk aversion (PRA) by Xie (2000), and the flexible three parameter (FTP) functional form by Conniffe (2007). Table 6.3 gives a brief summary of these functions. As can be seen, more and more parameters are being used to capture the curvature of the utility function to account for the complex relationship between wealth and risk aversion.

Table 6.2: Summary of utility functions

Utility function family	Basic form and variation	No. of para	Changes in risk aversion
Power	$U(x) = x^\alpha$	1	CRRA= $1 - \alpha$ DARA= $\frac{1-\alpha}{x}$
	$U(x) = \frac{x^r}{r}$	1	CRRA= $1 - \alpha$ DARA= $\frac{1-\alpha}{x}$
	$U(x) = (1 - \alpha)x^{1-\alpha}$	1	CRRA= $(1 - \alpha)^4 \alpha$ DARA= $\frac{(1-\alpha)^4 \alpha}{x}$
	$U(x) = \frac{x^{1-\alpha}}{1 - \alpha}$	1	CRRA= α DARA= $\frac{\alpha}{x}$
	$U(x) = \frac{x^{1-\alpha} - 1}{1 - \alpha}$	1	CRRA= α DARA= $\frac{\alpha}{x}$
Negative exponential	$U(x) = -\exp(-\alpha x)$	1	IRRA= αx CARA= α
	$U(x) = \begin{cases} \frac{1 - \exp(-\alpha x)}{\alpha} & \text{if } \alpha \neq 0 \\ x & \text{if } \alpha = 0 \end{cases}$	1	IRRA= αx CARA= α
			$ARA = \frac{1}{\left(\frac{x}{1-\gamma} + \frac{\mu}{\alpha}\right)}; RRA = \frac{1}{\left(\frac{1}{1-\gamma} + \frac{\mu}{\alpha x}\right)}$
Expo-power (HARA)	$U(x) = \frac{1-\gamma}{\gamma} \left(\frac{\alpha x}{1-\gamma} + \mu\right)^\gamma$	3	$\gamma = 1$: risk neutral, utility is linear $\gamma = 2$: utility is quadratic $\gamma < 1$: DARA, $\gamma > 1$: IARA, $\gamma = +\infty/-\infty$: CARA $\mu > 0$: IRRA, $\mu = 0$: CRRA, $\mu < 0$: DRRAs $\gamma < 1$ and $\alpha = 1 - \gamma$: power utility function $\gamma < 1$ and $\alpha = 1 - \gamma$ and $\mu = 0$: isoelastic utility function
	$U(x) = \frac{1 - \exp(-\sigma x^{1-\alpha})}{\sigma}$	2	$\sigma > 0, \alpha > 0$: I RRA, DARA $\sigma = 0, \alpha > 0$: CRRA
	$U(x) = \frac{1 - \exp(-\sigma \frac{x^{1-\alpha}}{1-\alpha})}{\sigma}$	2	$\alpha = 0, \sigma > 0$: CARA

6.3.2. Measuring Risk Preferences using PT

The specification of PT uses the utility function specified in Table 6.2 as the value function of the prospects embodied in each risky situation. As mentioned before, non-negative wealth is evaluated in EUT framework but changes in wealth, which are positive in the gain

domain and negative in the loss domain, are evaluated in PT. Therefore, in addition to risk aversion described above, PT measures loss aversion and probability weighting function.

6.3.2.1. Loss Aversion

Research on measuring loss aversion is still developing and has not reached a consensus (Abdellaoui, Bleichrodt, & Paraschiv, 2007). The principle proposed by Köbberling and Wakker (2005) for a utility function $U(v|r)$ with a reference point r offers a generalisation:

$$U(v|r) = \begin{cases} U^+(v|r) & \text{if } v \geq r \\ \delta U^-(-v|r) & \text{if } v < r \end{cases} \quad (6.5)$$

where v refers to the prospect's value. This principle explains well the *reflection effect* described by Kahneman and Tversky (1979). For a given reference point, a DM who is more risk averse in the gain domain will become more risk-seeking in the loss domain, which can be proved easily. According to the Pratt-Arrow measure of ARA, Person 1 is more risk averse than Person 2 if $r_1(v) = -\frac{U_1''(v)}{U_1'(v)} \geq r_2(v) = -\frac{U_2''(v)}{U_2'(v)}$ for all values of x .

Based on Köbberling and Wakker's (2005) specification for utility function with a reference point, assuming a simple utility function for x in the loss domain $U(-x)$ such that the utility function in the gain domain $U(v) = -U(-v)$, we have $r_1(-v) = \frac{U_1''(-v)}{U_1'(-v)}$,

$$r_2(-v) = \frac{U_2''(-v)}{U_2'(-v)}, \quad -\frac{U_1''(v)}{U_1'(v)} > -\frac{U_2''(v)}{U_2'(v)} \implies -\frac{U_1''(-v)}{U_1'(-v)} > -\frac{U_2''(-v)}{U_2'(-v)} \implies \frac{U_1''(-v)}{U_1'(-v)} < \frac{U_2''(-v)}{U_2'(-v)}, \text{ and}$$

thus $r_1(-v) < r_2(-v)$. With the presence of loss aversion, a DM will behave in a less risk-seeking way than s/he would be without loss aversion. In other words, people behave as predicted by EUT in the gain domain, but adjust their behaviours by loss aversion coefficient δ in the loss domain. Figure 6.3 illustrates Prospect Theory as proposed by Tversky and Kahneman (1979)

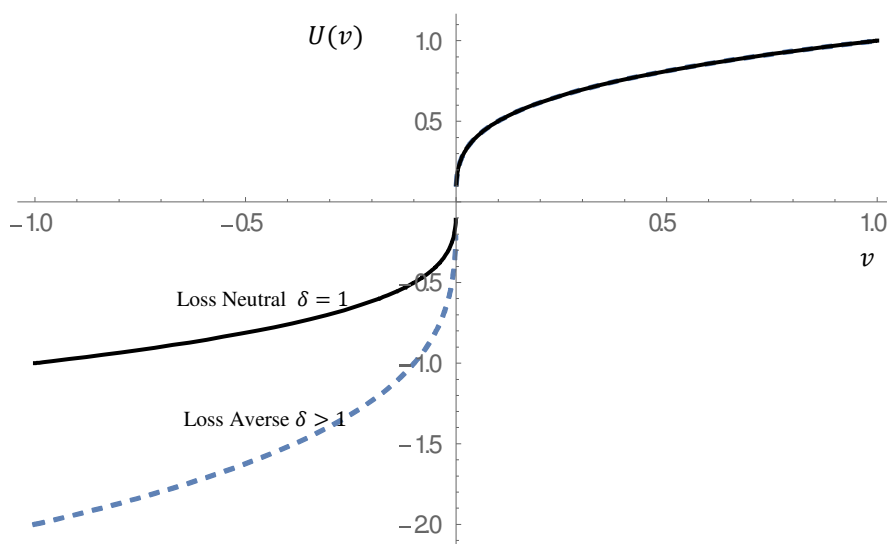


Figure 6.3: Different ranges of loss aversion

$$U(v) = v^{0.3} \text{ if } v > 0, -\delta(-v)^{0.3} \text{ if } v \leq 0$$

As can be seen, the reflection effect of risk aversions implies that risk aversion in the gain domain (positive utility) is accompanied by risk seeking in the loss domain (negative utility). Intuitively, DMs will prefer a sure gain over a probable gain, and a probable loss to a sure loss. In the presence of loss aversion (the dashed line) the DM appears to be more risk averse in the loss domain than otherwise would be, given the reflection effect. The loss aversion makes the utility function steeper in the loss domain than in the gain domain.

The development of loss aversion explains well the paradox of unrealistically high risk aversion for low-stake lottery described by Rabin (2000). In particular Rabin (2000, p. 1281) observed that “*expected –utility maximizers are (almost everywhere) arbitrarily close to risk neutral when stakes are arbitrarily small*”. Therefore, the risk aversion displayed when stakes of risk are small, such as those used in laboratory experiments, should not be related to diminishing marginal utility of wealth as traditionally assumed by EUT. He further noted the distinction between risk preferences over modest and large stakes: “*Data sets dominated by modest-risk investment opportunities are likely to yield much higher*

estimates of risk aversion than data sets dominated by larger-scale investment opportunities” (p1287). Because loss aversion describes the fact that the DM is more averse than would be otherwise for small-stake lottery, this is sometimes referred to as the first-order risk aversion (Barberis, Huang, & Thaler, 2006).

6.3.2.2 Probability Weighting Function

The other contribution of Prospect Theory (Kahneman & Tversky, 1979) is the development of probability weighting function that violates the linear combination of states in EUT. Kahneman and Tversky (1979) described the probability weighting function as a transformation of probability such that the probabilities may take different values in the evaluation phase. Generally, the main characteristics of this probability function are: overweighting of small probabilities, underweighting of large probabilities and *subcertainty*, namely the sum of the weights for complementary probabilities is less than 1, and *subproportionality*, namely the ratio of the corresponding decision weights is closer to unity when the probabilities are low rather than when they are high.

To satisfy these characteristics, several functional forms of probability weighting function have been proposed. Tversky and Kahneman (1992), Camerer and Ho (1994), and recently Santos-Pinto et al. (2015) used the one-parameter functional form as proposed by Goldstein and Einhorn (1987)

$$\omega(p) = \frac{p^\eta}{p^\eta + (1-p)^\eta} \quad (6.6)$$

Another example of one-parameter probability weighting function is proposed by Prelec (1998)

$$w(p) = \exp(-(-\ln p)^\alpha) \quad (6.7)$$

Gonzalez and Wu (1999) argued that one-parameter probability weighting function is not enough, because there are two logically independent, psychological properties to the weighting function: the discriminability and the elevation. The discriminability refers to the curvature of the function, implying how sensitive the DMs are to the probability. The elevation refers to the intercept of the function, implying how much weight the DMs give to each probability. They proposed a linear log odd function of the following form

$$\omega(p) = \delta p^\gamma / (\delta p^\gamma + (1 - p)^\gamma) \quad (6.8)$$

where $\delta = \exp \tau$ and τ is the intercept in the following log odd function of probability

$$\log(\omega(p)/(1 - \omega(p))) = \gamma \log(p/(1 - p)) + \tau \quad (6.9)$$

Prelec (1998) also generalised the one-parameter weighting function above to a two-parameter form

$$\omega(p) = \exp(-\delta(-\log(p))^\gamma) \quad (6.10)$$

6.3.3 Narrow Framing

Barberis et al. (2006) argued that loss aversion alone cannot explain the rejection of 50:50 low-stake lottery and acceptance of 50:50 high stake lottery. In particular, loss aversion (first-order risk aversion) explains the rejection of the immediately resolved lottery but not the rejection of the delayed lottery. In the delayed lottery, the people exposed to independent background risk will combine these risks with the lottery and benefit from diversification. However, with the presence of *narrow framing*, these people will reject the delayed lottery because they evaluate the lottery in isolation (p.1078). Although the concept of narrow framing is able to explain many puzzling behaviours, for example the equity premium puzzle and the low participation rates in the stock market, empirical tests of narrow framing and its origin are still lacking. The only work we are aware of is the

experiment conducted by Guiso (2015). We are not aware of any attempt to measure the effect of narrow framing using survey data.

6.4. Estimating Risk Preferences

Risk preferences can be estimated using various approaches. The approach that relies on observed DM's behaviours tends to use the EUT framework to model the problems faced by the DM. In agriculture, mathematical programming using production decisions has been used to measure risk preferences of farmers. The problem with this approach is that the behaviours may reflect the capital market imperfections and other constraints rather than the life-time utility (Binswanger & Sillers, 1983; Masson, 1972; Yesuf & Bluffstone, 2009).

Another approach is to elicit responses to risky situations in experiments or surveys with hypothetical or real incentivised pay-offs. This approach allows application of various theoretical frameworks and has been used to test PT versus EUT (Tanaka et al., 2010). In agriculture, an increasing number of works noted the non-EUT behaviours among farmers. Bocquého, Jacquet and Reynaud (2014) conducted a field experiment among French farmers and found evidence to support PT rather than EU. A review by Haushofer and Fehr (2014) and Carter (2016) showed that many aspects of preference other than risk aversion determine the risk behaviours of poor rural households.

The problem with risk preference elicitation, especially in PT rather than the EUT framework, is that it requires a multi-step procedure which is difficult to implement for a large sample and creates a cognitive burden on respondents, especially in relation to probabilistic concepts. Hypothetical and simple risk preference elicitation questions therefore offer advantages for studying risk preference of a large sample of rural households. For example, Binswanger (1980) conducted experiments in rural India and

found that measures of risk aversion calculated from hypothetical choices are more dispersed than that from incentivised experimental games, but not biased. Beattie and Loomes (1997) and Camerer et al. (1999) showed that for simple choice questions, respondents do not need real incentives to reveal their preferences. Dohmen et al. (2011) and Charness and Viceisza (2016) also found that simpler experiments work better among less numerate subjects, as more complex ones lead to lower levels of understanding and more noisy responses. However, comparison of elicited risk preference and observed behaviours yield limited agreement. In particular, Hellerstein, Higgins and Horowitz (2013) found that differentiating farmers into more versus less risk averse groups has an unexpected prediction: more risk averse farmers are more likely to have a crop insurance contract and are less likely to diversify their operation. However, a finer measure of risk aversion parameter has no explanatory power. Framing the risk preference elicitation questions in a farming context reduces these differences (Menapace, Colson, & Raffaelli, 2016).

Extensive research has tried to link individual characteristics to risk preferences in developed countries (Dohmen et al., 2011; Donkers, Melenberg, & Van Soest, 2001; Guiso & Paiella, 2008; Hartog, Ferrer-i-Carbonell, & Jonker, 2002) and developing countries (Binswanger, 1980; Tanaka et al., 2010). Two approaches are used. The predominant approach is to measure risk preference parameters first and then estimate the effect of individual characteristics on these parameters. Several authors have applied the second approach of including the characteristics into the specification used to measure risk preference parameters. In this approach no individual risk preference parameters are estimated. Instead, a maximum likelihood parameter estimate is obtained for the whole data sample (Holt & Laury, 2002; Reynaud & Aubert, 2013). By comparison, this approach is

not as flexible as the first approach, especially when risk preference parameters are used as the independent variable in the subsequent analysis.

6.5 Stability of Risk Preferences and Income Shocks

6.5.1 Theoretical Predictions of Stable Risk Preferences

Risk preference has been assumed to be stable, namely “*De Gustibus Non Est Disputandum*” (Stigler & Becker, 1977). However, empirical tests on stability of risk preference consistently reject this assumption (Chuang & Schechter, 2015). The apparent instability of risk preference has been explained using the EUT framework. In particular, risk vulnerability (Gollier and Pratt, 1996) refers to a characteristic of risk preference that makes people behave in a more risk-averse way if an unexpected background risk \tilde{y} is added to the initial wealth W :

$$E\tilde{y} \leq 0 \Rightarrow -\frac{EU''(W+\tilde{y})}{EU'(W+\tilde{y})} \geq -\frac{U''(W)}{U'(W)} \quad (6.11)$$

This is proved by Gollier and Pratt (1996, p. 1114) as long as the DM displays decreasing absolute risk aversion. However, PT proposes that DM does not combine current wealth W with the lottery pay-off but evaluates this pay-off with regards to a reference point. Tversky and Kahneman (1992) assumed the reference point to be the status quo (zero) (p.309). Extensive evidence on the tendency to evaluate the lottery in isolation appears to support this assumption (Barberis et al., 2006; Kahneman & Lovallo, 1993; Rabin, 2000). Because the current wealth does not enter into the evaluation framework of PT, the background risks should have no effect on the measured risk preference unless the risk preferences “mutate” themselves (Carter, 2016).

6.5.2 Empirical Evidence on Stable Risk Preferences

In contrast with the *De Gustibus Non Est Disputandum* assumption, risk preferences has been found to vary across different elicitation methods (Andersen, Hanspal, & Nielsen, 2014; Isaac & James, 2000; Lönqvist et al., 2015; Nielsen, Keil, & Zeller, 2013; Schoemaker, 1990) and domains (Deck et al., 2013; Einav, Finkelstein, Pascu, & Cullen, 2012). Even after controlling for different elicitation methods and domains, risk preference still varies over time, with the maximum estimated correlation coefficient to be 0.68, and general values hovering around only 0.2-0.3 (Chuang & Schechter, 2015).

Studies on the changes in risk preference over time have mostly focused on time-varying characteristics, especially wealth, which is closely related to the Arrow-Pratt risk aversion concept. Surprisingly, empirical evidences on changes in income, unemployment, health status and family composition point to limited impact on risk preference (Brunnermeier & Nagel, 2008; Chiappori & Paiella, 2011; Sahm, 2012). Notably, studies of this kind are subject to the endogeneity between risk preference and the determinants. For example, risk preference can lead to choices of occupations with preferred risks and returns. An instrumental variable for income is needed to solve for this endogeneity. The ideal instrument should be exogenous and positively correlated with income. Not surprisingly, a rapidly growing body of research has used weather shocks in economic analysis (Dell et al., 2014), in which an increasing number of papers use extreme events, especially natural disasters, to explain unstable risk and other preferences (Appendix 2). Weather shocks are time varying and exogenous. In addition, they have the appeal of a likely candidate to measure background risks (Gollier and Pratt, 1996).

As can be seen from Appendix 2, empirical studies on the effect of natural disasters on risk preferences are contradictory with evidence on both increased and decreased risk aversion,

and no effect on risk aversion. We notice that studies that find a decrease in risk aversion tend to focus on short-term effects of shocks, with elicitation made within one year from the occurrence time of the natural disaster (Eckel, El-Gamal, & Wilson, 2009; Hanaoka, Shigeoka, & Watanabe, 2015; Kahsay & Osberghaus, 2017; Page, Savage, & Torgler, 2014). On the other hand, studies that find an increase in risk aversion are generally conducted 3-10 years after the disaster (Andrabi & Das, 2010; Cassar, Healy, & von Kessler, 2017; Van Den Berg, Fort, & Burger, 2009). Using three-wave panel data, Ingwersen (2014) found that the 2004 Tsunami temporarily reduced the risk aversion of affected Indonesians but increased their measured risk aversion in 2009, five years after the event.

6.6 Conclusion

This chapter provides an overview of the most relevant theoretical and empirical works on risk preference and its relation with income shocks. There appear several theoretical and empirical issues that need to be addressed. Theoretical predictions of risk behaviours in the presence of background risk are contradictory. For example, Barberis et al. (2006) argued that the presence of background risk will make a DM more likely to accept a lottery to diversify risk exposure, unless s/he displays narrow framing. Risk vulnerability proposed by Gollier and Pratt (1996, p. 1114) however predicted that addition of background risk will make the DM more risk averse. This characteristic of risk preference is developed within the EUT framework. In contrast, PT implies that income shocks should have no effect on risk preference because current wealth is not considered in the PT evaluation framework. The empirical evidence on the relation between natural disasters and time-varying risk preferences requires a clear distinction between the change in the location on the utility function and the change in the shape of that function. The location change refers

to the wealth effect of natural disasters. The Pratt-Arrow risk aversion theorized that absolute risk aversion (ARA) decreases, and relative risk aversion (RRA) increases as wealth increases. While decreasing ARA has been consistently found among empirical works¹⁰, the empirical evidences on RRA are mixed and evidences of increasing, decreasing and constant RRA have all been obtained. Regardless of the relationship between risk aversion and wealth, both theoretical work and empirical evidence suggest the necessity to properly account for the wealth effect of natural disasters. The consequent increase in risk aversion may well be due to the fact that people become poorer because of the shocks. In Chapter 4, we show that the tendency to report shocks is affected by regional as well as household characteristics. Therefore using self-reported losses rather than instrumented income effect due to natural disasters can introduce endogeneity between risk preference and reported wealth effect due to the potential self-reporting bias. Finally, it is necessary to test PT against EUT. For a decreasing marginal utility function and non-negative wealth, EUT predicts risk-aversion, but PT predicts risk aversion in the gain domain and risk-seeking in the loss domain. Therefore, there are at least three conflicting effects of natural disasters on DM behaviours towards risk: 1) decreased wealth makes DMs more risk averse; 2) falling into the loss domain causes them to become more risk seeking; and 3) loss aversion makes DM opt for fewer losses. The changes in risk behaviours may be due to the presence of various risk preference parameters, rather than the change in the utility shape. In the next chapter, we address these issues in an empirical analysis of the VARHS' risk preferences data.

¹⁰ Gollier and Pratt (1996, p1117) argued such convexity is a natural assumption

CHAPTER 7

Empirical Evidence on Risk Preferences and Income Shocks

7.1 Introduction

Chapter 6 reviews the literature on the theory of decision-making under uncertainty. It highlights the differences between predictions from the EUT and CPT models. In particular PT, as a positive model, generalises EUT to account for the range of behaviours shown by individuals when taking risky decisions. The PT model predicts that DM who are risk averse for gains are often risk-seeking and loss-averse in the loss domain. A different strand in the literature, related to background risk in an EUT setting, predicts that accounting for changes in background risks, such as the frequency of natural disasters, will make a DM more risk averse (Gollier and Pratt, 1996). However, in contrast, PT implies that background risk, incorporated through stochastic wealth, should have no effect on risk preferences as wealth does not enter the DM's evaluation process (Tversky and Kahnmen, 1992).

This empirical chapter uses two hypothetical lotteries administered in 2010 and 2012 survey waves to measure risk aversion and loss aversion. The first set of models addresses the issue of bias in the lottery responses due to relatively low levels of participation in those questions. These results are used to test a hypothesis related to narrow-framing which is where respondents assess lotteries in isolation from the background risk.

In possession of un-biased estimates of utility function curvature and loss aversion, the second set of models tests for the stability of household risk preferences between the 2010 and 2012 survey waves.

This chapter therefore compares the two theories in explaining the changes in response to hypothetical lottery questions of poor rural households in Vietnam. Furthermore, the stability of reference points in CPT and how to estimate reference points is discussed.

The last model is a calibration of an imputed reference point shift based on the assumption that utility curvature is constant between the two periods. This provides an alternative explanation for the instability of preferences.

The structure of the chapter is as follows. The next section presents an overview of our identification strategy and econometric specification. Section 7.3 describes the data we use for empirical tests. Section 7.4 describes our measurement of risk preferences using EUT and PT frameworks and compares the differences in these measurements. Section 7.5 presents the empirical evidence for the first set of models that analyse the tendency to participate in the lottery. Section 7.6 presents the empirical evidence for the second set of models that compare EUT and PT in explaining risk behaviours of households after a shock incident. Section 7.7 presents an analysis on imputed reference points and the determinant of the shift in reference points. Finally section 7.8 concludes.

7.2 Identification Strategy

In this chapter we aim to untangle different effects of typhoons on the changes in risk behaviours of a sample of rural households in Vietnam. We first consider the effect of typhoons on the tendency to take risk by participating in a lottery set. For those who revealed their risk preference by participating in the lottery, we evaluate the two effects of typhoons on the risk preference parameters. The first effect is through the income effect, which is supposed to result in a change in the location on the utility function for a lower wealth level. After controlling for the income effect, we consider the background risk effect, which is understood as a change in risk behaviours at the same level of wealth but with an increase in the possibility of the future wealth being adversely affected. The identification strategy includes two sets of models, one on the participation in the lottery

and the other on the change in risk preferences. As typhoons tend to have many household effects, including participation in the lottery, the household wealth level and the household risk preferences, usage of the same typhoon shock variable to analyse these effects will lead to problems in econometric identity. To mitigate these problems, we use different measures of typhoon shocks in these identifications. For lottery participation analysis we use a measure of typhoon severity interacted with its intensity. For income analysis we use a measure of typhoon severity. For risk preferences analysis we use two weather variables that are positively correlated with typhoon occurrence. Section 7.2.1 and section 7.2.2 below elaborate more on these strategies.

7.2.1 Participation in the Lottery

The refusal to participate in a lottery has been hypothesised to be the consequence of ‘narrow framing’. This effect was first noted by Barberis et al (2008) to describe the tendency to evaluate a lottery in isolation. Without narrow framing, the addition of background risks will make a DM agree to participate in a lottery to diversify his/her exposure. Because of narrow framing the same DM refuses to participate in the lottery (section 6.3.3). In this section, we test the hypothesis that exposure to salient risks, such as natural disasters makes the DM frame his/her choices less narrowly and therefore more likely to participate in a lottery. Assuming that the probability of a household giving a positive WTP is affected by a set of invariant household characteristics X_i and time-varying household characteristics Z_{it} : $P_{it}(WTP_{it} > 0) \equiv P_{it}(X_i, Z_{it})$. The dummy variable \hat{P}_{it} takes the value of 1 if the given WTP is positive and 0 otherwise. We estimate the following probit model:

$$Pr(\hat{P}_{it}(WTP > 0)) = \beta_0^{mill} + \beta_1^{mill}X_i + \beta_2^{mill}Z_{it} + Typhoon_{ct} Number_{ct} + \gamma_{jt} + \xi_{it}^{mill} \quad (7.1)$$

The superscript *mill* identifies that a coefficient will be used to calculate the Inverse Mill Ration (IMR) to address the self-selection bias in subsequent estimations that use responses of participants in the lottery (Woodridge, 2010, p.813-814). $Typhoon_{ct}$ refers to the wind speed in knots of the typhoon and $Number_{ct}$ refers to the number of the typhoons that hit the commune c in period t . γ_{jt} is the dummy variable of the survey supervisors to control for the interviewer bias (Binswanger, 1980). A similar estimation is made with the use of logit instead of probit model to compare with the following fixed-effect model.

$$\text{Log}(OR_{it}) = \alpha_2 Z_{it} + Typhoon_{ct} Number_{ct} + \gamma_{jt} + \mu_{it} \quad (7.2)$$

where the odd ratio of household i in period t participating in the lottery is:

$$OR_{it} = \Pr(\widehat{P}_{it}(WTP > 0)) / (1 - \Pr(\widehat{P}_{it}(WTP > 0))) \quad (7.3)$$

For a balanced panel data in two survey waves 2010 and 2012, we identify three patterns of participation in the same lottery: (i) participation in either 2010 or 2012 (ii) participation in both 2010 and 2012 and (ii) non-participation in both 2010 and 2012. We conduct a multinomial logit estimation of three patterns with the same explanatory variables used in (7.1)

7.2.2 Stability of Risk Preferences

Estimating risk preferences as a function of income is problematic due to endogeneity. To overcome this econometric problem we instrument income by using typhoon wind speed and exogenous household characteristics X_i and Z_{it} in the following instrumental variable (IV) regression:

$$y_{it} = \beta_0^{IV} + \beta_1^{IV} X_i + \beta_2^{IV} Z_{it} + \beta_3^{IV} Typhoon_{i \in C, t} + \gamma_i + \xi_{it}^{IV} \quad (7.4)$$

where y_{it} is per capita income of household i in year t and other variables are defined above.

The fitted income \hat{y}_{it} from (7.4) captures the income effect of typhoons. Therefore, inclusion of IV income \hat{y}_{it} in the following regression will control for the wealth effect of typhoons on parameters of risk preferences (RP):

$$RP_{it} = \beta_0^{RP} + \beta_1^{RP}X_i + \beta_2^{RP}Z_{it} + \beta_3^{RP}\hat{y}_{it} + \beta_4^{RP}Weather_{i \in C, t} + IMR + \xi_{it}^{RP} \quad (7.5)$$

where RP_{it} is a measurement of risk preference parameters for the household head of household i either in EUT or PT framework, $Weather_{i \in C, t}$ refers to weather conditions of commune C where household i reside at time t . In this specification, we evaluate both the income effect of typhoons on risk preferences (β_3^{RP}) and the effect of background risks (β_4^{RP}) after controlling for the effects of other variables. In (7.5), other than IV income, we include the *Inverse Mill Ratio (IMR)* which is calculated from the probit regression in model (7.1) to correct for possible self-selection bias for those who did not reveal their risk preferences by not participating in the lottery. We use the interval regression of (7.5) where risk preference parameters are measured in interval (*int*):

$$RP_{it}^{low} - RP_{it}^{high} = \beta_0^{int} + \beta_1^{int}X_i + \beta_2^{int}Z_{it} + \beta_3^{int}\hat{y}_{it} + \beta_4^{int}Weather_{i \in C, t} + IMR + \xi_{it}^{int} \quad (7.6)$$

7.3 Data

7.3.1 Household Characteristics

We constructed a balanced panel of 3,103 households from two survey waves 2010 and 2012 of VARHS when data on risk preference were collected. The panel is reduced to 3,037 households after exclusion of per capita income outliers (Osborne and Overbay, 2004) and households with only one year's observation. Details of the survey methods and the statistical analyses of the VARHS can be found in Chapter 3 and this reduced panel data set has similar characteristics (Table 7.1)

Table 7.1: Summary of Household and Respondent Characteristics

Variable	Definition	2010		2012	
		Mean	Std.Dev	Mean	Std.Dev
<i>Income</i>	Per capita annual income (\$)†	1,697	1,539	2,256	2,005
<i>Consumption</i>	Per capita annual food consumption (\$)†	948	709	1,578	1,263
<i>HH Size</i>	Household size (persons)	4.68	1.92	4.59	1.92
<i>Labour</i>	Proportion of labour-age members (%)	0.57	0.26	0.58	0.28
<i>Children</i>	Proportion of children under 10 (%)	0.13	0.17	0.12	0.16
<i>Male Member</i>	Proportion of male members (%)	0.49	0.19	0.49	0.20
<i>Illiteracy</i>	Respondent having no education (1=yes, 0=no)	0.18	0.38	0.18	0.38
<i>Education</i>	Education levels (years)	5.88	3.88	5.92	3.89
<i>Age</i>	Age (years)	50.14	13.85	51.87	13.66
<i>Gender</i>	Gender (1=male, 0= female)	0.82	0.38	0.81	0.39
<i>Health shock</i>	% of annual days family having ill members (%)	0.03	0.06	0.03	0.07
<i>Kinh</i>	Ethnicity (1=Kinh, 0=minority)	0.62	0.49	0.62	0.49
<i>Illness</i>	Respondent being ill in the last 2 weeks (1=yes, 0=No)	0.19	0.39	0.19	0.39
<i>Married</i>	Respondent being married (1=yes, 0=otherwise)	0.84	0.37	0.82	0.39
<i>Army</i>	Respondent used to serve in the army (1=yes, 0=No)	0.27	0.44	0.26	0.44

†Amounts are deflated to the 2010 base and then converted to USD using IMF PPP; No. of households = 3,037

In the sample, it is notable that there is a reduction in households below the \$2/day poverty line (27% in 2010 and 19% in 2012) and a marked increase in the average household per capita income and consumption from 2010 to 2012. We focus on characteristics that are likely determinants of risk preferences (Gloede, O, 2015). The household heads, who were interviewed for the risk preference questions, were on average over 50 years old, with most being male with primary education (6 years of schooling). The sample has a mix of Kinh people and other minorities. We further include dummy variables to indicate the marriage status and war experience of the respondents and characteristics of the household structure. The sample represents the typical rural Vietnam household, with approximately 2-3 members of working age between 17 and 60 years old and approximately half being male. These characteristics tend to be stable over time. There is increasing evidence from the literature on the effects of personal emotions on responses to risk elicitation questions (Eckel, El-Gamal, & Wilson, 2009; Haushofer & Fehr, 2014). Therefore we include a dummy variable to indicate if the respondent has been ill in the last two weeks to capture the potential short-term effect of emotions. This variable is different from the health shocks

which are measured by the percentage of total labour days lost due to sickness during the year before survey time.

7.3.2 Risk Preferences Elicitation

The two risk preference questions used in the VARHS are hypothetical and straightforward.

The exact wordings of the two questions are:

Question 1 (Lottery A and B)

Consider an imaginary situation where you are given the chance of entering a state-run lottery where only 10 people can enter and 1 person will win the prize.

- A. How much would you be willing to pay for a 1 in 10 chance of winning a prize of 2,000,000 VND?
B. How much would you be willing to pay for a 1 in 10 chance of winning a prize of 20,000,000 VND?*

Question 2 (50:50 Lottery)

You are given the opportunity of playing a game where you have a 50:50 chance of winning or losing (for example, a coin is tossed so that you have an equal chance of it turning up) either heads or tails. In each case, choose whether you should accept or reject the option of playing:

- a. You have a 50% chance of losing 2,000 VND and a 50% chance of winning 6,000 VND
b. You have a 50% chance of losing 3,000 VND and a 50% chance of winning 6,000 VND
c. You have a 50% chance of losing 4,000 VND and a 50% chance of winning 6,000 VND
d. You have a 50% chance of losing 5,000 VND and a 50% chance of winning 6,000 VND
e. You have a 50% chance of losing 6,000 VND and a 50% chance of winning 6,000 VND
f. You have a 50% chance of losing 7,000 VND and a 50% chance of winning 6,000 VND*

The first one, hereinafter called *lottery game*, was designed by Hartog et al.(2002)¹¹.

Similar designs have been used in many large-sample surveys, such as the Italian Households' Income and Wealth survey in 1995, the Brabant survey in Netherlands in 1993, the Accountants Survey in Netherlands in 1999, and the Japanese Household Panel Survey on Consumer Preferences and Satisfaction in 2011-2012. In particular, the same design was also used by Van den Berge (2009) to study the relationship between natural disasters and risk preference and found to yield more significant results than the experimental method, which probably was due to the noises in the survey's responses to

¹¹ The exact wording of the question used by Hartog (2002) is "Among 10 people, 1000 guilders are disposed of by lottery. What is the most that you would be willing to pay for a ticket in this lottery?". 1000 guilders approximate 12 mil VND. The lower pay-off level of 2 mil VND, approximately 100 US\$, is equal to the average monthly wage rate of the sample.

this method (p18). With a small pay-off¹² and the neutral probability $\frac{1}{2}$ for both gains and losses, the second question, hereinafter called the *50:50 game*, is often used to measure loss aversion rather than risk aversion (Novemsky & Kahneman, 2005; Rabin, 2000). The design of the *50:50 game* is similar to the Ordered Lottery Selection (OrLS) developed by Binswanger (1980) to measure risk aversion, except that in our case, the respondent was asked to accept or reject one lottery where the gains and the probabilities are fixed, and the losses are increased. We therefore use the *lottery game* to measure risk aversion and *50:50 game* to measure loss aversion.

There is a potential probability weighting effect as the probability changes from $\frac{1}{10}$ in the *lottery game* to $\frac{1}{2}$ in the *50:50 game*. However, the OrLS version that “restricts probabilities to $\frac{1}{2}$ make it virtually impossible to use these responses to make inferences about probability weighting” (Harrison & Rutström, 2008, p. 55). We therefore do not consider probability weighting in our analysis of risk preference.

In the VARHS both questions are asked at the end of a lengthy household survey without any ‘warm-up’ introduction. Despite the simplicity and careful wording of the two questions to avoid the impression of gambling¹³, those who gave a positive willingness-to-pay (WTP) to the *lottery game* only account for about 50% of the total sample, and more than 50% rejected all options in the *50:50 game* question. The high non-response rate is similar to that of other dataset which use the same lottery question. This may be due to the abrupt elicitation of risk preference. Guiso and Paiella (2008) argued that this approach has the advantage of effectively excluding noisy responses from respondents with a poor understanding of the questions, and avoiding the Hawthorne effect that participants try to answer in a way they think compatible with the introductory text. Another possible reason

¹² 2000 VND approximate 10 US cent, and also are of a very small value in Vietnam.

¹³ Except for state-run lotteries and licensed casinos, gambling is illegal in Vietnam.

is the effect of *narrow framing* described above (Barberis et al, 2008). Nevertheless, there appears high consistency across these responses: those who gave a zero or no responses to the first part of the *lottery game* (Lottery A) were more likely to do so in the second part (Lottery B) and reject all losses in the *50:50 game* (Table 7.2). We focus on the observations with positive WTPs and treat all non-responses and zero WTPs as non-responses.

Table 7.2: Cross tabulation of the responses to the lottery game and the 50:50 game (N=3,037)

		2010			2012		
		<i>Lottery A</i>			<i>Lottery A</i>		
		<i>WTP>0</i>	<i>WTP= 0</i>	<i>Non-response</i>	<i>WTP>0</i>	<i>WTP=0</i>	<i>Non-response</i>
<i>Lottery B</i>	WTP > 0	1,286	13	6	1,837	-	11
	WTP = 0	6	1,492	-	-	12	-
	WTP = .	5	-	229	-	-	1,177
<i>50:50 Game</i>	Accept some	771	78	103	984	-	86
	Reject all	507	1,426	129	792	12	1,100
	Accept all	19	1	3	61	-	2
		<i>Lottery B</i>			<i>Lottery B</i>		
		<i>WTP>0</i>	<i>WTP=0</i>	<i>Non-response</i>	<i>WTP> 0</i>	<i>WTP = 0</i>	<i>Non-response</i>
<i>50:50 Game</i>	Accept some	767	78	107	992	-	78
	Reject all	520	1,419	123	795	12	1,097
	Accept all	18	1	4	61	-	2

Table 7.3 shows a high instability of response patterns from 2010 to 2012. Only 50% made the same participation decision in both lotteries and the *50:50 game*. The accepted losses are highly unstable. The highest probability of giving the same accepted loss is 19% and at the level of VND 4000.

Table 7.3: Summary of participation rates in two waves 2010-2012**Panel A: Lottery question**

2010		2012					
		Lottery A			Lottery B		
Lottery A	WTP>0	Others*	All	WTP>0	Others*	All	
WTP>0	0.65	0.35	0.43	0.65	0.35	0.43	
Others*	0.57	0.43	0.57	0.58	0.42	0.57	
All	0.60	0.40	0.61	0.39			
		Lottery B			Lottery A		
Lottery B	WTP>0	Others*	All	WTP>0	Others*	All	
WTP>0	0.65	0.35	0.43	0.65	0.35	0.43	
Others*	0.58	0.42	0.57	0.57	0.43	0.57	
All	0.61	0.39	0.60	0.40			

Panel B: 50:50 game

		2012							
2010	Reject all	2	3	4	5	6	Accept all	All	
Reject all	0.65	0.09	0.11	0.08	0.04	0.00	0.02	0.68	
2	0.64	0.09	0.12	0.12	0.02	-	0.02	0.04	
3	0.61	0.08	0.14	0.10	0.05	0.00	0.01	0.12	
4	0.54	0.08	0.13	0.19	0.05	-	0.02	0.09	
5	0.49	0.10	0.19	0.18	0.02	-	0.02	0.04	
6	0.64	0.10	0.10	0.12	0.04	-	-	0.02	
Accept all	0.30	0.17	0.09	0.09	0.26	-	0.09	0.01	
All	0.63	0.09	0.12	0.10	0.04	0.00	0.02		

*others refer to either non-responses or zero values of the WTPs

Figure 7.1 shows the high levels of risk aversion in our sample. The responses in the *lottery game* appear to be less dispersed in 2012, but the WTP values in both years are much below the expected pay-off. The average WTP (VND 75,320) is 38% of the expected pay-off when the maximum possible pay-off is VND 2 million, and decreases to only 18% (VND 365,480) for VND 20 million. In 2010, a small proportion of respondents (2.3%) gave WTP values greater than the maximum possible gain for lottery A in 2010. Because these responses lead to sure losses, we also treat them as non-responses. Figure 7.1c shows a slightly higher acceptance rate in 2012 for the VND 2000 loss, but almost identical rates between 2010 and 2012 for higher losses. In all cases the acceptance rate is substantially lower than the loss-neutral benchmark.

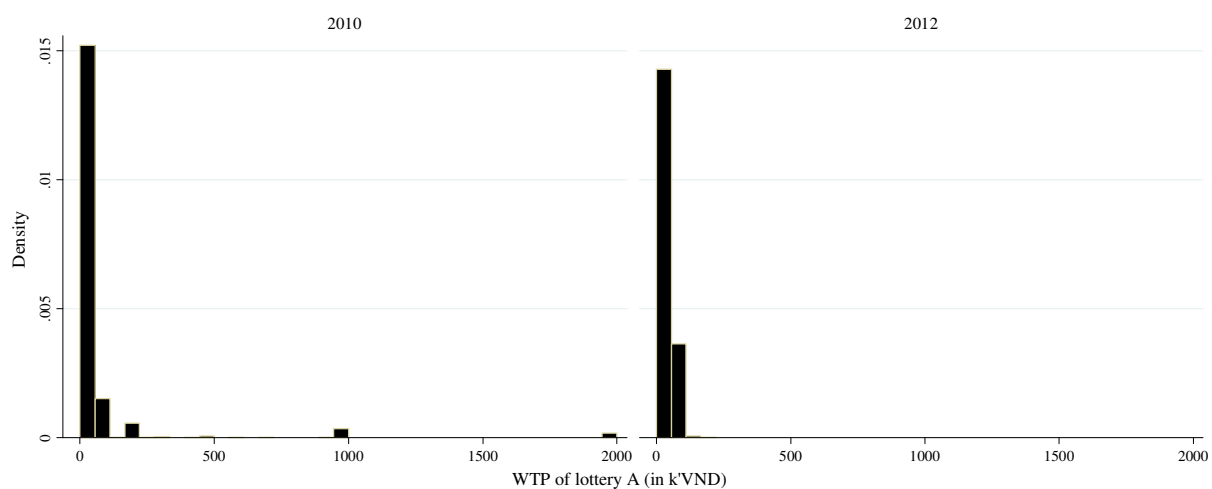


Figure 7.1a. Distribution of WTP for Lottery A

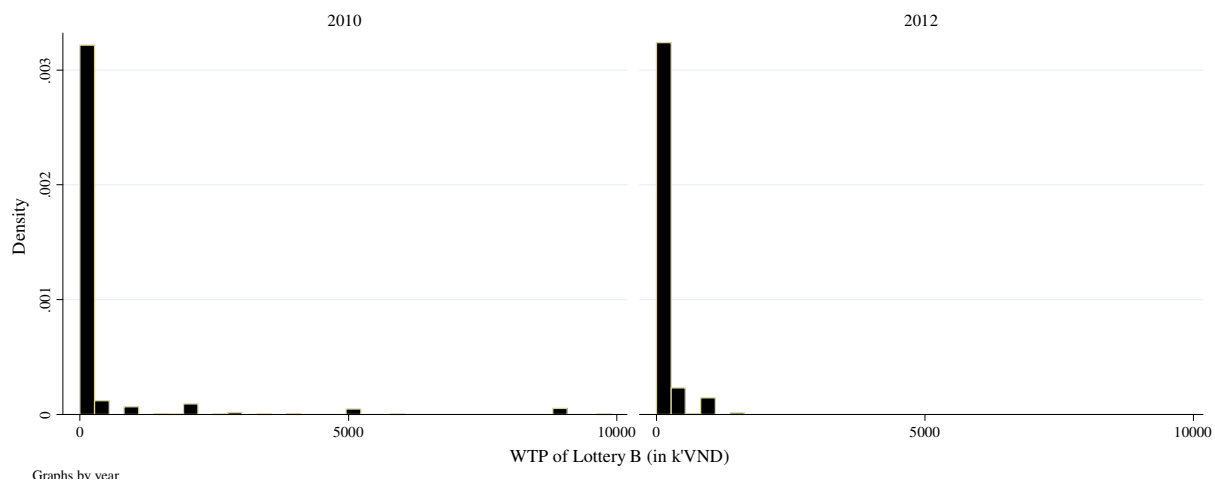


Figure 7.1b. Distribution of WTP for Lottery B

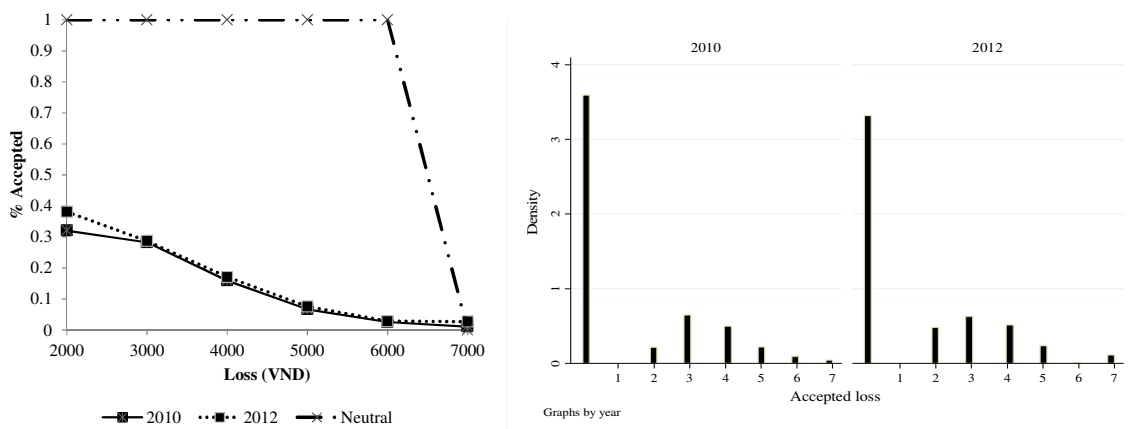


Figure 7.1c. Distribution of accepted losses in 50:50 game

7.3.3 Shock Variables

Vietnam is located between the latitudes of 8 and 23 degrees north of the Equator where typhoons occur (Chapter 3). Typhoons rank among the most damaging natural disasters in Vietnam. Except for the North West region where typhoons rarely occur, all other regions, especially those in the central areas, are highly exposed to the risk of severe typhoons. Using recorded typhoon data obtained from the Joint Typhoon Warning Centre (UNISYS, 2017), we track the movements of storm eyes which are then matched with the sampled communes within a 125-km radius around the storm eyes. All sampled households that reside in these communes accordingly are deemed to be affected by typhoons. We use wind speed in knots at each storm eye to capture the severity of the typhoons. The variable takes the value of zero if the commune did not suffer from any typhoon in the survey year.

Typhoons can weaken after landing and become tropical depressions with the potential benefits of increased rainfall and limited damage due to lower wind speed. We further distinguish the effects of typhoons into the rainfall effect and the wind effect using the Climate Forecast System Reanalysis (CFSR, 2017). As the average distances between a communal centre and the surrounding virtual CRSR grid stations are from 24 to 71 km, we assign the weather data of each station to the communes within a 30 km radius from the station's coordinate to ensure that each commune has at least one virtual station. We calculate the total annual precipitation (mm) and the average daily wind speed (m/s) for each sampled commune¹⁴, which are then assigned to the residing households in the commune. Table 7.4 presents a summary of the weather shocks.

¹⁴ If there is more than one virtual station in a commune, we take the average of the total annual precipitations and average wind speeds of these stations.

Table 7.4: Summary of Weather Shocks

Weather Shocks	2010		2012	
	Mean	Std.Dev	Mean	Std.Dev
Average wind speed of typhoons (Knot)	20.55	23.19	16.05	20.23
Total precipitation ('000mm)	5.94	1.69	8.82	2.80
Average daily wind speed (m/s)	1.86	0.44	1.45	0.44

7.4 Measuring Risk Preferences from the Survey Data

7.4.1 Measuring Risk Preferences Using EUT

7.4.1.1 Measuring Risk Aversion without Assumption of Utility Function

Hartog et al (2002) proposed a measure of risk aversion based on the EUT without the use of wealth w . For a WTP of λ for a lottery with a probability p of winning a prize of Z , the participant is indifferent between buying and not buying the lottery: $(1 - p)U(w - \lambda) + pU(w - \lambda + Z) = U(w)$. Using a second-order Taylor expansion of the equation around $U(w)$, we have: $(1 - p)[U(w) - \lambda U'(w) + 0.5\lambda^2 U''(w)] + p[U(w) + (Z - \lambda)U'(w) + 0.5(Z - \lambda)^2 U''(w)] = U(w)$. After rearranging, we have the measure of absolute risk aversion (ARA):

$$\rho = -\frac{U'''(w)}{U''(w)} = \frac{2(pZ - \lambda)}{pZ^2 - 2pZ\lambda + \lambda^2} \quad (7.7)$$

The specification in (7.7) is a function that will change value after it reaches the local minimum. Specifically, two such values of λ are $pZ \left[1 - \sqrt{\left(\frac{1}{p} - 1\right)}\right]$ and $pZ \left[1 + \sqrt{\left(\frac{1}{p} - 1\right)}\right]$. Since $p < 1$ we can identify the value of WTP beyond which ρ increases rather than decreases as WTP increases: $pZ \left[1 + \sqrt{\left(\frac{1}{p} - 1\right)}\right]$, which corresponds to 0.8 mil VND for lottery A and 8 mil VND for lottery B. One way to correct for this situation and to ensure monotonicity between the measured ρ and WTP is to apply the following adjustment:

$$\rho = \begin{cases} \frac{2(pZ-\lambda)}{pZ^2-2pZ\lambda+\lambda^2} & \text{if } \lambda < pZ \left[1 + \sqrt{\left(\frac{1}{p} - 1\right)} \right] \\ -\frac{2}{\sqrt{(1-p)pZ^2}} - \frac{2(pZ-\lambda)}{pZ^2-2pZ\lambda+\lambda^2} & \text{if } \lambda \geq pZ \left[1 + \sqrt{\left(\frac{1}{p} - 1\right)} \right] \end{cases} \quad (7.8)$$

The mean values of our calculated ρ for the low-stake lottery of 2mil VND are comparable to those of Hartog et al. (2002) and much lower than those of Van Den Berg et al (2009). However, ρ also depends on wealth. As the maximum pay-off increases from 2 to 20 million VND the change in ρ shows a corresponding decrease in risk aversion (Table 7.5). However, if we multiply ρ with the expected lottery pay-off in kVND like Van Den Berg et al. (2009), we find an increase in the imputed relative risk aversion from 0.15 ($Z=2$ mil) to 0.17 ($Z=20$ mil). Such increase in (relative) risk aversion has been shown by Holt and Laury (2005) to be due to the order effect of participating in a low-payment choice before making a high-payment choice.

Table 7.5: Comparison of risk aversion measures of ρ

	VARHS			Hartog et al. (2002)			Van Den Berg et al. (2009)	
	2010	2012	All	Brabant Survey	Accountants Survey	GDP Newspaper survey	Nicaragua	Peru
Low-stake lottery	0.000563 (.000673)	0.000846 (.000166)	0.000729 (.000472)	0.00154 (0.00070)	0.00077 (0.0011)	0.00034 (0.00011)	0.0015 (0.002)	0.011 (0.007)
High-stake lottery	0.0000715 (.0000644)	0.0000948 (.0000106)	0.0000852 (.0000437)				0.0022 (0.0008)	0.001 (0.0001)
Low-stake lottery	0.000386 (.0011)	0.000846 (.000166)	0.000656 (.000754)					
<i>adj</i>								
High-stake lottery	0.0000700 (.0000702)	0.0000948 (.0000106)	0.0000846 (.0000475)					
<i>adj</i>								
No. of obs	2,602	3,685	6,287	2,011	1,599	17,097	107	101

Low-stake lottery and high-stake lottery respectively refer to Lottery A and B in VARHS. The *adj* refers to the adjusted value of ρ .

Figure 7.2a,b shows rightly skewed distributions of ρ , implying a high level of risk aversion in the sample. The risk neutrality and risk-seeking behaviours were observed in the first year of elicitation but were not present in 2012.

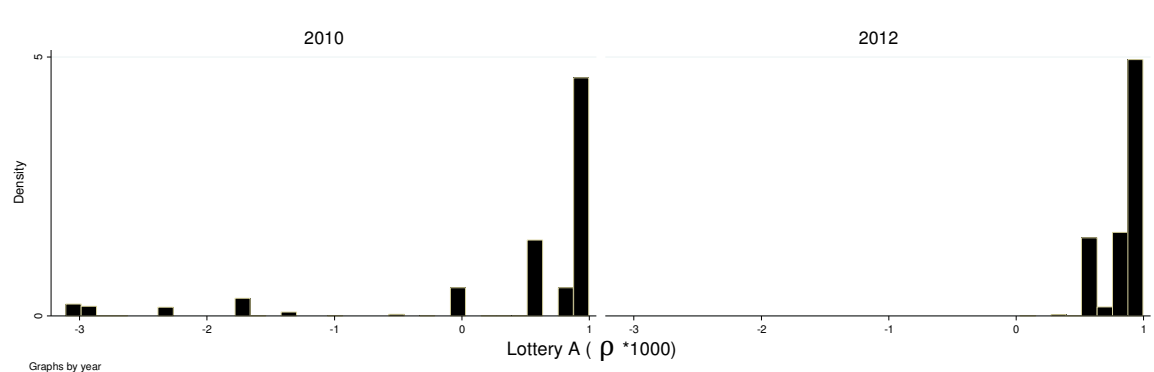


Figure 7.2a. Distribution of adjusted ρ for Lottery A

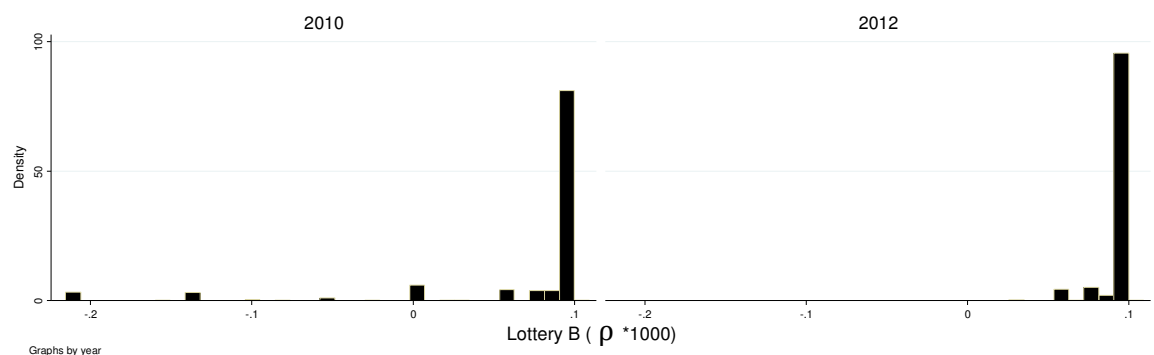


Figure 7.2b. Distribution of adjusted ρ for Lottery B

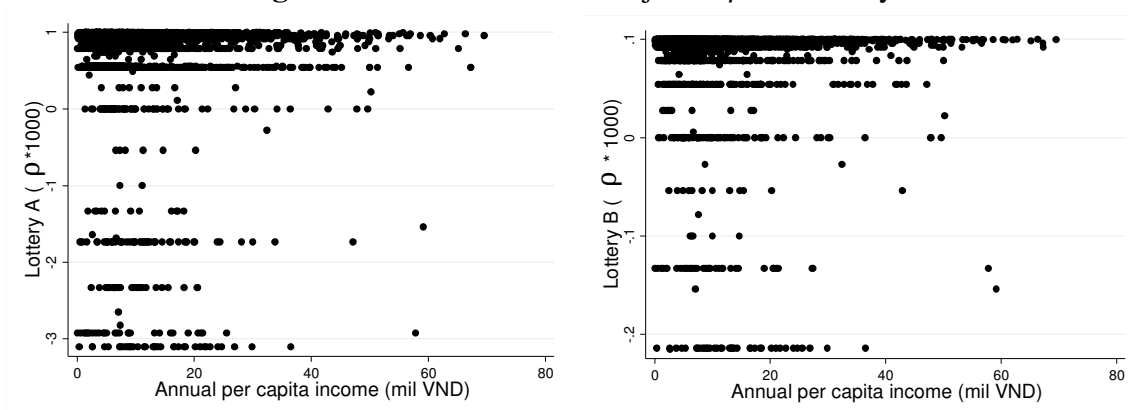


Figure 7.2c. Relationship between adjusted ρ and per capita income

The scatter plot 7.2c shows blocks of ρ values, which is due to the fact that the answers tend to be in multiple of 5000. The apparent positive relation between ρ and income is due

to self-selection bias. When we correct for the self-selection bias due to non-response answers in a standard regression, a negative relationship between income and ρ is established as expected.

7.4.1.2 Measurement of risk aversion with assumption of utility function

Instead of linearising the utility function using Taylor expansion, Guiso and Paiella (2008) proposed a solution to measure risk aversion by numerically solving for a utility function. Since no difference is found between power and exponential utility function (Guiso & Paiella, 2008, p. 1114), we solve the following equation for the relative risk aversion RRA using similar CRRA form:

$$\frac{w^{(1-RRA)}}{1-RRA} = p \frac{(w+Z)^{(1-RRA)}}{1-RRA} + (1-p) \frac{(w-\lambda)^{(1-RRA)}}{1-RRA} \quad (7.9)$$

where w refer to the current wealth level of the household and required for the estimation. The absolute risk aversion can be easily calculated from the relative risk aversion: $ARA = RRA/w$. Specification (7.9) requires the wealth level w to be positive and larger than the amount of WTP. Our measure of ARA gives an average value of 0.0127 for lottery A and 0.0085 for lottery B, which is comparable to the average value of 0.01978 by Guiso and Paiella (2008). As noted earlier by Rabin (2000), the RRA measured using this method is “absurdly” high (Figure 7.3a). Moreover, a verifying regression that corrects for the non-response rate shows a positive relationship between ARA and income, which contrasts with the negative relation of ρ . For a very wealthy household in the sample, the increase in the amount of WTP for the lottery is not much higher than the amount of WTP given by the much poorer household. The method of mapping risk aversion to WTP assuming terminal wealth model therefore leads to a higher measured risk aversion for richer households than when current wealth is not included in the estimation of ρ .

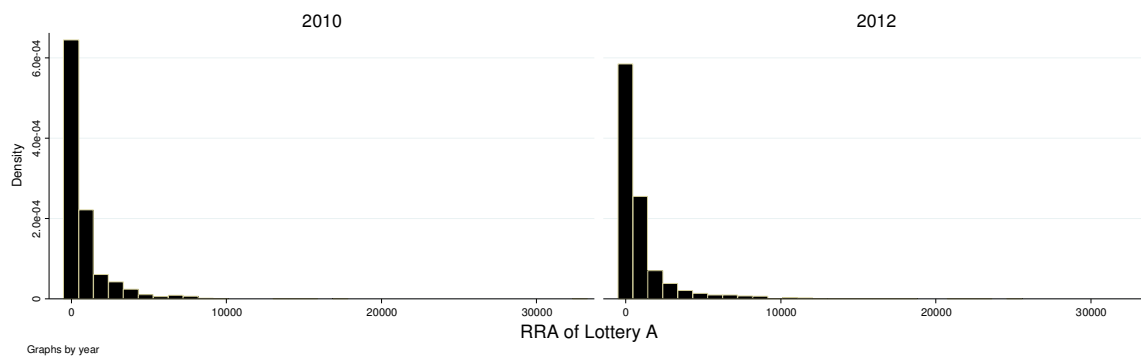


Figure 7.3a. Distribution of RRA for Lottery A

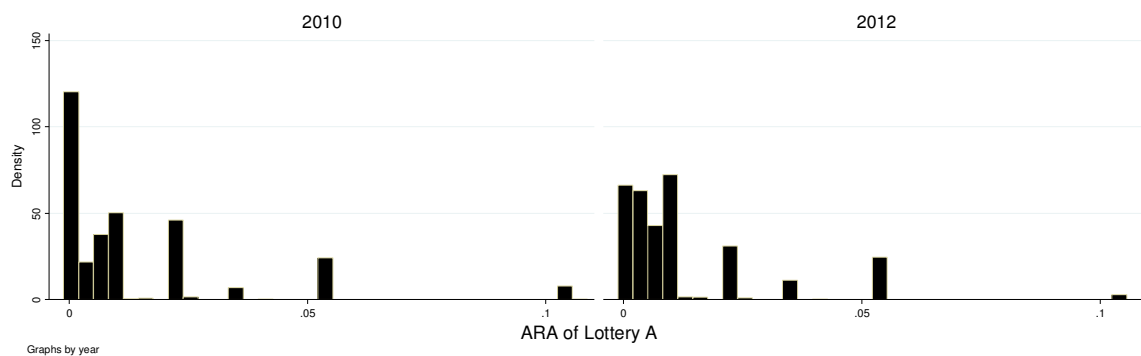


Figure 7.3b. Distribution of ARA for Lottery A

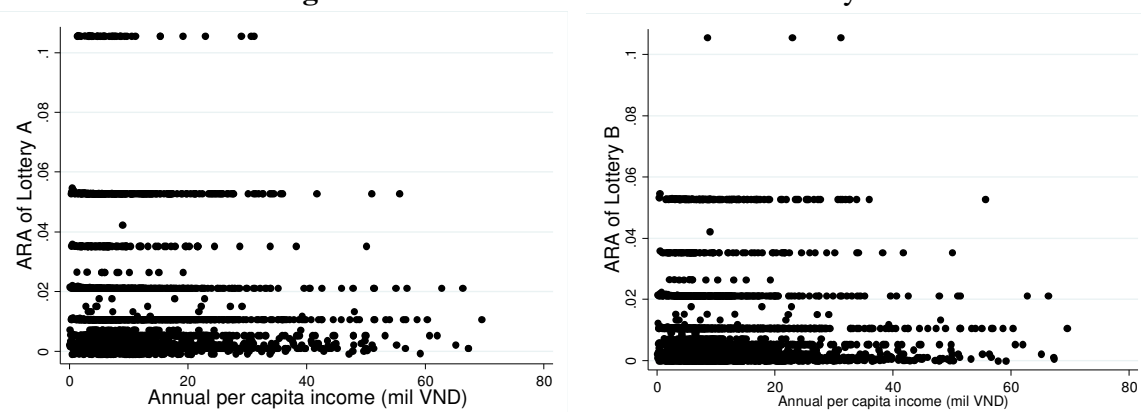


Figure 7.3c. Relationship between ARA and per capita income

Note: Figure 7.3a,b have similar shapes when we use measures of RRA and ARA for Lottery B

7.4.2 Measuring risk preferences using PT

Similar to Tanaka, Camerer and Nguyen (2010) we assume a power utility function $U(x) = x^\alpha$ and apply the principle proposed by Köbberling and Wakker (2005) as follows:

$$U(x) = \begin{cases} x^\alpha & \text{if } x \geq 0 \\ -\delta(-x)^\alpha & \text{if } x < 0 \end{cases} \quad (7.10)$$

where α is the utility curvature parameter (UCP) and δ the loss aversion parameter. Because the risk preference elicitation questions in the VARHS do not provide sufficient information for us to estimate the probability weighting function, we assume that the probability weighting function parameter equals one and is the same in both the loss and the gain domains. We further assume the respondents' WTP values in the *lottery game* are equal to their certainty equivalences of the lotteries. For each household, we solve the following set of equations for α and δ :

$$\begin{cases} \lambda^\alpha = pZ^\alpha \\ \delta \text{loss}^\alpha = \text{gain}^\alpha \end{cases} \quad (7.11)$$

where λ, p, Z are as defined above for the *lottery game*, λ and Z are in kVND, and *loss* is the maximum accepted loss in kVND for a fixed *gain* of 6 kVND in the 50:50 *game*. Since the losses in the 50:50 game are proposed at discrete levels, the true maximum accepted losses are more likely to fall in the intervals defined by these discrete losses. We thus define the following ranges of loss aversion coefficients given a parameter α :

$$\delta^{high} = \begin{cases} \left(\frac{\text{gain}}{\text{loss}}\right)^\alpha & \text{if } 7 \geq \text{loss} > 0 \\ +\infty & \text{if } \text{loss} = 0 \text{ (reject all)} \end{cases} \quad (7.12)$$

$$\delta^{low} = \begin{cases} \left(\frac{\text{gain}}{\text{loss}+1}\right)^\alpha & \text{if } 7 > \text{loss} > 0 \\ \left(\frac{\text{gain}}{\text{loss}+2}\right)^\alpha & \text{if } \text{loss} = 0 \\ -\infty & \text{if } \text{loss} = 7 \text{ (accept all)} \end{cases}$$

With two levels of lottery pay-off in lottery A and B, we obtain two values of curvature α , and accordingly two values of loss aversion δ . Compared to estimations made by Tanaka (2010), our sample displays a higher level of risk aversion and lower level of loss aversion, which possibly is due to our inability to estimate probability weighting function (Table 7.16). We also notice that on average, the sample became more risk averse but less loss averse from 2010 to 2012. Similar to measure of ρ we also find an increase in risk aversion for the same DM from lottery A to lottery B.

Table 7.6 Comparison of risk aversion measures of α, δ

	VARHS				Tanaka et al. (2010)	
	2010	2012	All	North	South	All
Low-stake lottery α	0.54 (0.88)	0.53 (0.14)	0.53 (0.57)	0.63 (0.34)	0.59 (0.35)	0.61 (0.34)
High-stake lottery α	0.57 (0.51)	0.39 (0.12)	0.46 (0.35)			
Low-stake lottery δ	1.63-1.86 (2.3-4)	1.42-1.47 (0.33-0.37)	1.51-1.64 (1.53-2.6)	1.61-2.9 (1-3.47)	2.43-3.53 (2.08-3.35)	2.05-3.23 (1.72-3.41)
High-stake lottery δ	1.42-1.52 (1.26-1.71)	1.29-1.32 (0.23-0.26)	1.34-1.40 (0.85-1.12)			
No. of obs	2,575	3,685	6,250	83	98	181

Low-stake lottery and high-stake lottery respectively refer to Lottery A and B in VARHS.

Figure 7.3 shows a left-skewed distribution of UCP α . As a lower α implies higher levels of risk aversion, the skew again reflects a highly risk-averse sample. Compared to EUT risk aversion measures, the distribution of α is much more reasonable. The values of $\alpha > 1$ corresponds to risk-seeking behaviours. The scatter plot further shows a possible negative relationship between UCP and income. Further empirical evidence on this relationship will be provided in Table 7.12.

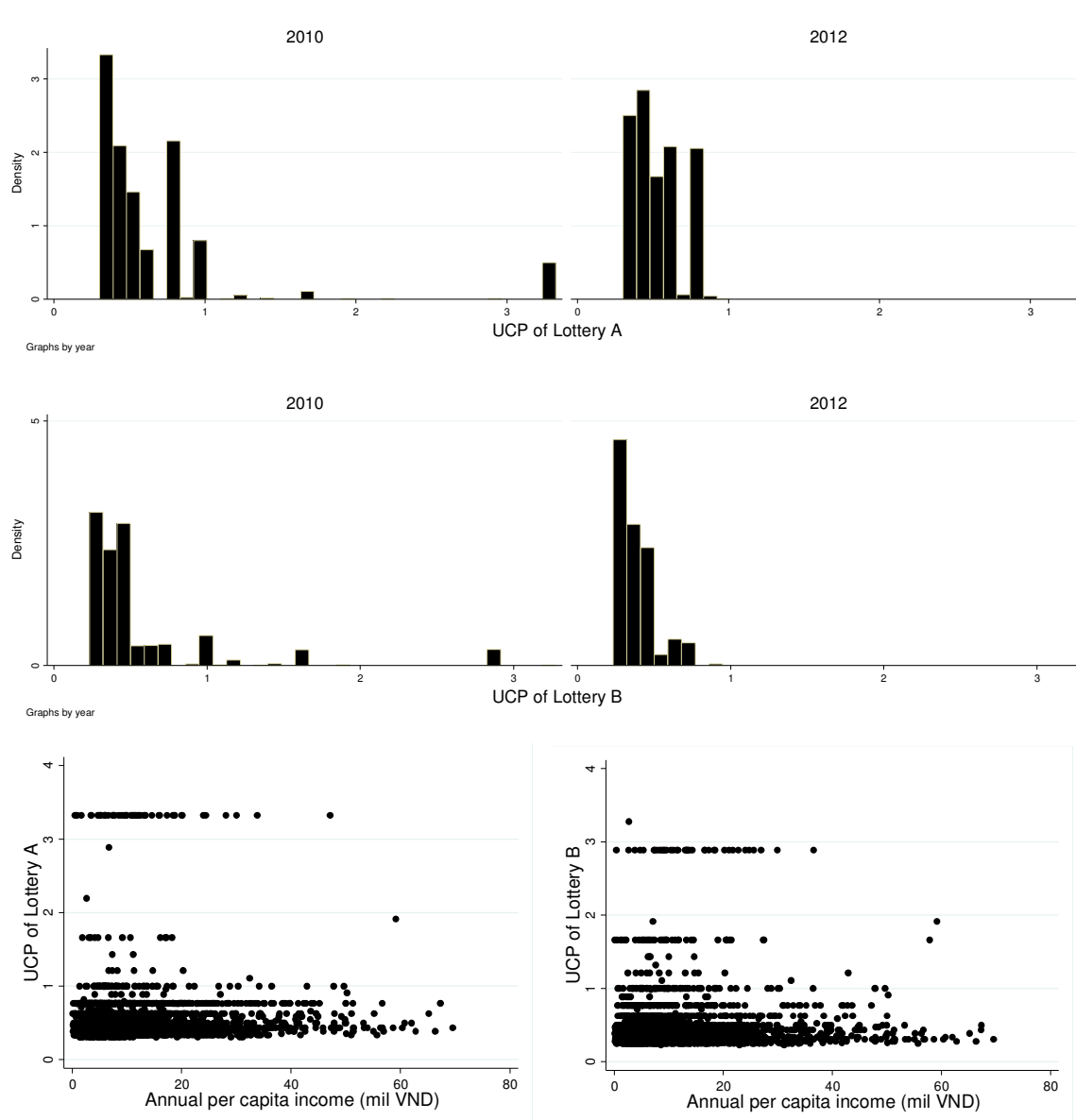


Figure 7.4. Distribution of UCP α measured in PT framework

7.5 Empirical Evidence on Participation in the Lottery

Table 7.7 considers both within- and between-household variations in column (1), (2), (4) and (5) in explaining lottery participation. We find that male individuals from large families who are not an ethnic minority are more likely to participate in the lottery. Moreover, households with better economic conditions with larger food consumption budget are also more likely to participate in the lottery. The occurrence of typhoon does not change the

decision of the participants. The coefficients are highly comparable for lottery A and B. When we consider the within-household effect only in column (3) and (6), the effects of household characteristics are no longer significant except for the gender effect, which becomes much stronger. The gender effect comes from the change in the surveyed heads of the same household. The decrease in significance of other characteristics possibly is due to their considerable stability. The effect of the consumption budget is also stronger and highly significant. However, we find evidence opposing the narrow framing hypothesis. For the same household with similar consumption budgets, the experience of weather shocks makes the household less likely to take additional risk from the lottery. This behaviour is more consistent with the prediction made by risk vulnerability using EUT framework (Gollier and Pratt, 1996).

Table 7.7: Tendency to participate in the lottery

	Lottery A			Lottery B		
	Probit	Random Effect	Fixed Effect	Probit	Random Effect	Fixed Effect
	[1]	logit	logit	[4]	logit	logit
	[1]	[2]	[3]	[4]	[5]	[6]
<i>Gender</i>	0.179*** (0.051)	0.292*** (0.081)	0.818** (0.409)	0.19*** (0.051)	0.31*** (0.081)	1.001** (0.403)
<i>Kinh</i>	0.108** (0.055)	0.178** (0.087)		0.118** (0.054)	0.195** (0.087)	
<i>Illiteracy</i>	0.005 (0.049)	0.002 (0.083)	0.06 (0.212)	0.006 (0.049)	0.004 (0.083)	0.055 (0.213)
<i>Age</i>	-0.001 (0.001)	-0.001 (0.002)	0.025* (0.013)	-0.001 (0.001)	-0.001 (0.002)	0.023* (0.013)
<i>HH Size</i>	0.033*** (0.01)	0.054*** (0.017)	0.021 (0.055)	0.032*** (0.01)	0.052*** (0.017)	0.014 (0.055)
<i>Labour</i>	0.113 (0.071)	0.177 (0.115)	0.461 (0.386)	0.122* (0.071)	0.191* (0.115)	0.259 (0.385)
<i>Children</i>	-0.058 (0.121)	-0.103 (0.202)	-0.223 (0.61)	-0.071 (0.121)	-0.125 (0.202)	-0.426 (0.613)
<i>Male Member</i>	0.057 (0.095)	0.095 (0.155)	0.128 (0.509)	0.05 (0.094)	0.084 (0.155)	0.03 (0.505)
<i>Illness</i>	0.011 (0.046)	0.023 (0.072)	-0.013 (0.132)	0.029 (0.046)	0.053 (0.072)	0.023 (0.132)
<i>Consumption</i>	0.016*** (0.004)	0.027*** (0.006)	0.053*** (0.011)	0.015*** (0.004)	0.025*** (0.006)	0.053*** (0.011)
<i>Typhoon*Number of typhoons</i>	0.00003 (0.001)	0.00008 (0.001)	-0.008*** (0.002)	-0.000004 (0.001)	0.00002 (0.001)	-0.009*** (0.002)
<i>Interviewer effect included but not reported</i>						
<i>Constant</i>	-0.236* (0.132)	-0.385* (0.213)		-0.222* (0.132)	-0.362* (0.213)	
<i>No of hh.</i>	3,037	3,037	2,912	3,037	3,037	2,930
<i>No of obs</i>	6,074	6,074	1,456	6,074	6,074	1,465
<i>R/ Chisq</i>	0.065	481.1***	370.9***	0.065	486.4***	374***

Standard Error in bracket. *, **, *** Significant at 10%, 5% and 1% level. Result in probit estimation is used for calculating IMR

The effect of the consumption budget is not present in Table 7.8. Apparently the difference in participation patterns is driven by household characteristics rather than by household income proxied by their food consumption expenditure. We observe the same effects of gender, ethnicity and household size. Households who participate in both survey years have more members, are not an ethnic minority and the participants are male. The proportion of labour force increases the participation tendency in at least one survey. Surprisingly, households exposed to typhoons are more likely to participate, but in one year only. This finding is consistent with Bchir and Willinger (2013) and Page et al. (2014) who found that residents in volcano-affected and flood-affected regions display riskier behaviours than those unaffected. The salient shock effect appears to reduce the narrow framing effect across different regions, but not across time.

Table 7.8: Multinomial logit model of response patterns

	Lottery A	Lottery B
	Random Effect	
Base scenario: Never participate in any round of lottery		
Participate in one round of lottery		
Gender	0.299** (0.127)	0.283** (0.128)
Kinh	0.476*** (0.141)	0.505*** (0.141)
Illiteracy	-0.15 (0.125)	-0.165 (0.126)
Age	-0.001 (0.004)	-0.001 (0.004)
HH Size	0.019 (0.027)	0.026 (0.027)
Labour	0.327* (0.185)	0.369** (0.187)
Children	0.139 (0.316)	0.086 (0.316)
Male Member	0.267 (0.24)	0.297 (0.24)
Illness	-0.026 (0.096)	-0.018 (0.096)
Consumption	-0.001 (0.007)	-0.003 (0.007)
Typhoon*Number of typhoons	0.003** (0.001)	0.003*** (0.001)
Constant	0.531 (0.354)	0.485 (0.356)
Participate in two rounds of the lottery		
Gender	0.467*** (0.158)	0.492*** (0.159)
Kinh	0.619*** (0.168)	0.656*** (0.168)
Illiteracy	-0.048 (0.146)	-0.044 (0.145)
Age	-0.003 (0.005)	-0.003 (0.005)
HH Size	0.089*** (0.032)	0.086*** (0.032)
Labour	0.388* (0.214)	0.442** (0.216)
Children	-0.198 (0.367)	-0.193 (0.368)
Male Member	0.201 (0.285)	0.205 (0.284)
Illness	-0.018 (0.118)	0.02 (0.118)
Consumption	0.012 (0.008)	0.01 (0.008)
Typhoon*Number of typhoons	0.0002 (0.001)	0.0006 (0.001)
Constant	-0.325 (0.414)	-0.354 (0.415)
Interviewer effect included but not reported		
No of hh.	3,037	3,037
No of obs	6,074	6,074
Rpseudo	0.078	0.077

Standard Error clustered at household level in bracket. *, **, *** Significant at 10%, 5% and 1% level.

7.6 Empirical Evidence on Stability of Risk preferences

Table 7.9 shows the significant negative effect of the typhoons on household income. On average, one knot increase in the typhoon wind speed leads to a 34k VND decrease in per capita income (Model 1). In Model 2, higher wind speeds are shown to decrease income, whereas more precipitations increase income. Therefore, in our sample, high wind speeds act as a proxy for the loss domain and precipitations the gain domain. All control variables have expected signs. Health shock in the form of ill members has a large and significant negative effect on per capita income. Households with older and better-educated household heads, and more proportion of labour-aged members and more male members tend to earn more. The presence of young children also creates extra pressure for the household. The results are robust across the two models.

Table 7.9: Effects of weather shocks on income[†]

Per Capital Income (mil VND)	Model 1	Model 2
Typhoon (knot)	-0.034*** (0.007)	
Wind Speed (m/s)		-1.818*** (0.419)
Precipitation (10k mm)		0.434*** (0.06)
Health shock	-8.239*** (2.383)	-9.459*** (2.346)
Kinh	-2.463 (3.8)	-3.113 (3.783)
Male	-1.135 (1.186)	-0.508 (1.071)
Education	0.214*** (0.08)	0.169** (0.077)
Age	0.202*** (0.035)	0.075*** (0.028)
Children	-5.674*** (1.463)	-4.752*** (1.448)
Labour	6.631*** (1.182)	5.709*** (1.16)
Male member	4.296*** (1.621)	4.043*** (1.563)
<i>H.H Fixed Effects included</i>		
R^2	0.899	0.9035
<i>No. of obs</i>	6,074	6,074

[†] Robust standard errors in brackets; *, ** and *** for significance at 10%, 5% and 1% levels. Model 1 is used to calculate IV income

Table 7.10 panel A presents the weather shock effects on ρ after controlling other characteristics. Women are found to be more risk averse than men in developed countries (Hartog et al., 2002; Kahsay & Osberghaus, 2017) but the effect is insignificant in developing countries (Binswanger, 1980; Gloede. O, 2015; Tanaka et al., 2010; Yesuf &

Bluffstone, 2009). In our sample, we find that male respondents are significantly less risk averse than female respondents. Kinh people from households with more labour-aged members and larger family size are also less risk averse than other minorities. Family member's health shocks make the respondents more risk averse, but the experience of illness in the recent two weeks makes them less risk-averse. The effect of being ill is similar to the evidence of emotions increasing risk-loving among earthquake evacuees in United States (Eckel et al., 2009). Interestingly, we find that individuals who used to serve in the Vietnamese army are significantly less risk averse than other people and this effect is robust in all modifications. We find that IV income significantly decreases risk aversion in both lottery A and B. As the income variable is instrumented with the occurrence of typhoons, this result confirms the income effect of typhoons. We further find evidences supporting the effect of background risks in increasing risk aversion. As the probability of typhoon occurrence increases, ρ increases significantly. However, we find a pattern of risk-seeking behaviour that is associated with a loss domain. In particular, the coefficient of rainfall, an income-increasing factor, is positive, and that of wind speed, an income-decreasing factor, is negative. When we exclude the observations with risk-seeking and risk-neutral behaviours ($WTP \leq Expected\ payoff$) the signs of both variables become negative, which verifies that risk-seeking behaviour is strongly associated with the income-decreasing factor, wind speed. In other words, individuals with similar characteristics and income levels living in an area with higher typhoon wind speeds will be more risk-seeking than areas with lower wind speeds. On the other hand, individuals with similar characteristics and income levels who live in an area with higher precipitation will be more risk-averse than areas with lower precipitation. This is the reflection effect described by PT:

households become more risk averse in the gain domain and more risk-seeking in the loss domain.

Table 7.10: Effect of weather shocks on risk preference parameters- EUT[†]

Panel A	Dependent variable: ρ (*10,000) adjusted		
	Lottery A		Lottery B
	Adjusted [1]	Adjusted – Exclude [2]	Adjusted
<i>Characteristics</i>			
Household size	-0.01**(0.004)	-0.001 (0.002)	-0.001*(0.0005)
Health shock	0.249*** (0.086)	0.068*(0.039)	-0.023 (0.018)
Male	-0.053*(0.032)	0.024*(0.013)	-0.002 (0.004)
Kinh	-0.059***(0.026)	0.013 (0.011)	0.0003 (0.003)
Education	-0.0005 (0.002)	-0.002*(0.001)	-0.0002 (0.0003)
Age	0.001 (0.001)	-0.0002 (0.0003)	0.0001 (0.0001)
Illness	-0.044*(0.024)	-0.006 (0.009)	-0.003 (0.003)
Army	-0.034*(0.019)	-0.001 (0.007)	-0.007*** (0.002)
Married	-0.012 (0.025)	-0.01 (0.012)	0.006 (0.004)
Interviewer effect included but not reported			
<i>Shock effect</i>			
IV income	-0.004*** (0.002)	-0.001 (0.0004)	-0.0002 (0.0001)
Precipitation	0.021*** (0.003)	0.003*** (0.001)	0.002*** (0.0002)
Wind speed	-0.124*** (0.025)	0.028*** (0.007)	-0.019*** (0.002)
Typhoon Probability	0.156*** (0.033)	0.059*** (0.013)	0.012*** (0.003)
IMR	-0.478*** (0.158)	0.204*** (0.059)	-0.012 (0.015)
Const.	1.193*** (0.156)	0.571*** (0.057)	0.116*** (0.013)
R^2	0.103	0.158	0.191
No. of obs	3,038	2,876	3,153
No. of hhs	2,251	2,198	2,309
Panel B	Dependent variable: Risk tolerance=1/ARA in CRRA utility function		
	Lottery A [1]	Lottery A-Exclude [2]	Lottery B
<i>Characteristics</i>			
Household size	11.1 (18.9)	5.1 (5.1)	92.4 (178.3)
Health shock	-75.4 (302.8)	-159.3*(92.4)	-11,027.3*** (2920.1)
Male	-59.7 (92.9)	-64.7*(34.3)	1,198.2 (1185.6)
Kinh	-456*** (135.4)	-33.4 (26.6)	-202.7 (1176.6)
Education	13.8 (9)	4.8*(2.4)	-150.8*(83.4)
Age	1 (2.4)	0.7 (0.6)	-12.5 (22.7)
Illness	54 (86.4)	11.5 (22)	1,471.4 (902.2)
Army	-24.8 (62.5)	9.8 (18.9)	-279.9 (632.1)
Married	-128.9 (91.1)	31 (29.9)	-18.7 (936.7)
Interviewer effect included but not reported			
<i>Shock effect</i>			
IV income	8.5 (5.2)	2.1*(1.1)	123.3*(64.1)
Precipitation	-72.4*** (11.3)	-9*** (3.1)	-334.8*** (79.4)
Wind speed	160.3*** (78.7)	-63.5*** (18.5)	2,796.1*** (942.3)
Typhoon Probability	-412.4*** (112)	-135.9*** (31.6)	-2,405.7** (1162.2)
IMR	-930** (412)	-501.8*** (145.7)	11,100.2** (5444.4)
Const.	1,444.4*** (400.6)	1,009*** (141.5)	-9,126.4* (5436.9)
R^2	0.100	0.145	0.047
No. of obs	3,129	2,874	3,147
No. of hhs	2,293	2,198	2,306

[1] includes risk-neutral and risk-seeking behaviours; [2] excludes risk-neutral and risk-seeking behaviours; [†] Standard errors clustered at the household level; p-values in brackets; *, ** and *** for significance at 10%, 5% and 1% levels.

When we use the risk tolerance parameter proposed by Guiso and Paiella (2008) in Panel B, the household and individual characteristics both lose significance and change signs. However, the signs of typhoon effects are similar. Households with higher incomes are more tolerant of risks. After controlling the differences in characteristics and income, people live in areas with higher probability of typhoons are less tolerant of risks, but those with higher wind speed are more tolerant, and those with higher precipitation are less tolerant. These behaviours are similarly driven by risk-neutral and risk-seeking behaviours. The evidence on the reflection effect again questions the suitability of using EUT in explaining risk preference behaviours. Indeed, Quiggin (2003) proved that for rank-dependent preferences, one of the non-EUT preferences, the presence of independent background risk contradictorily decreases risk aversion. Using experiments, Lusk and Coble (2008) found that, despite the general support of increased risk aversion with the introduction of background risks, *“this finding depends on how individual incorporate endowments and background gains and losses into their utility functions”* (p.315).

In Table 7.12 we consider the effects of typhoons on PT measures of risk preference. We perform both random and fixed-effect models for the curvature parameter UCP, but only random effect model for loss aversion as the specification is interval regression. Respondents with a large family are less risk averse for both lottery A and B, but this characteristic has no effect on loss aversion. Health shocks in the family make people significantly more risk averse in lottery A and more loss averse in lottery B. Male respondents are significantly less risk averse and loss averse than female respondents. Kinh people are also less risk averse than other minority groups, but much more loss averse than other minority people as shown in lottery A. We find no effect of education on the changes in risk aversion, which agrees with the varied and context-dependent empirical evidence on

education effect. For example, Binswanger (1980) conducted experiments among poor rural Indians and found a limited effect of education on risk aversion at low pay-off levels, but a negative and often significant effect at intermediate and high pay-off levels. However, lottery B shows that higher education levels significantly lead to higher loss aversion. While age has no effect on risk aversion, it significantly increases loss aversion. The state of being ill does not affect the risk aversion, but highly increases the loss aversion of the participants in lottery A. Being in the army makes respondents much less risk averse in both lottery A and B, but has no effect on their loss aversion.

When we consider only within-household variations most stable effects disappear, except for several varying characteristics. In both lottery A and B, the change from female to male individuals of the same households surprisingly lead to more risk-adverse choice. People with higher education and people who used to serve in the army are also less risk-averse than other members from the same family.

When we consider both between- and within-household variations of typhoon effects in the random model, the income effect significantly decreases risk aversion α in both lottery A and B. As UCP is (assumed to be) independent of wealth, we attribute the income effect more to the between-household than within-respondent differences. Similar to Tanaka et al (2010), respondents having a higher per capita income have a less concave utility function. However, when we consider within-household variations only in the fixed-effect regression, income significantly increases risk aversion in the small-stake lottery A. This effect becomes insignificant in the high stake lottery B, but the coefficient is the same. The income effect is not significant for loss aversion, but the sign is not consistent.

Table 7.11: Effect of weather shocks on risk preference parameters- PT[†]

Panel A	Dependent variable: Utility curvature in power utility function α			
	Lottery A		Lottery B	
	Random	Fixed effect ^{††}	Random	Fixed effect
<i>Characteristics</i>				
Household size	0.008**(0.004)	-0.019 (0.018)	0.007**(0.003)	-0.013 (0.013)
Health shock	-0.245*** (0.083)	-0.628 (0.492)	0.169 (0.141)	0.505 (0.414)
Male	0.066** (0.032)	-0.17* (0.094)	0.011 (0.028)	-0.177*** (0.065)
Kinh	0.079*** (0.023)		-0.01 (0.021)	
Education	-0.001 (0.002)	0.0254** (0.0111)	0.001 (0.002)	0.0073 (0.0072)
Age	-0.001 (0.001)	0.004 (0.0036)	0 (0.001)	-0.0004 (0.0027)
Illness	0.033 (0.024)	0.053 (0.066)	0.017 (0.018)	-0.038 (0.046)
Army	0.034* (0.019)	0.081 (0.058)	0.052*** (0.016)	0.105** (0.052)
Married	0.015 (0.023)	-0.019 (0.084)	-0.045 (0.029)	0.023 (0.046)
Interviewer effect included but not reported				
<i>Shock effect</i>				
IV income	0.004*** (0.002)	-0.0369** (0.0144)	0.001* (0.001)	-0.0133 (0.0122)
Precipitation	-0.016*** (0.002)	-0.011** (0.0053)	-0.017*** (0.002)	-0.006* (0.0034)
Wind speed	0.094*** (0.024)	0.12** (0.06)	0.119*** (0.017)	0.156*** (0.039)
Typhoon Probability	-0.141*** (0.032)		-0.094*** (0.022)	
IMR	0.498*** (0.161)	-0.975 (0.617)	-0.028 (0.105)	-0.495 (0.437)
Const.	0.16 (0.16)	1.787** (0.698)	0.371*** (0.096)	1.187** (0.535)
R^2	0.088	0.133 ^{†††}	0.197	0.295 ^{††}
<i>No. of obs</i>	3,038	1,574	3,153	1,688
<i>No. of hhs</i>	2,251	787	2,309	844
Panel B				
	Dependent variable: Interval $\delta_{low} - \delta_{high}$			
	Lottery A		Lottery B	
	Random		Random	
<i>Characteristics</i>				
Household size		0.008 (0.051)		0.024 (0.021)
Health shock		-1.05 (1.057)		0.922* (0.488)
Male		0.276 (0.278)		-0.231* (0.126)
Kinh		0.874*** (0.267)		0.107 (0.115)
Education		0.018 (0.022)		0.033** (0.014)
Age		0.005 (0.007)		0.006** (0.003)
Illness		0.64** (0.327)		-0.002 (0.093)
Army		-0.044 (0.162)		0.123 (0.097)
Married		0.24 (0.224)		0.113 (0.105)
Interviewer effect included but not reported				
<i>Shock effect</i>				
IV income		0.004 (0.009)		-0.003 (0.003)
Precipitation		-0.001 (0.026)		-0.014 (0.009)
Wind speed		1.286*** (0.396)		0.449*** (0.111)
Typhoon Probability		-0.986*** (0.358)		-0.391*** (0.118)
IMR		4.728*** (1.575)		0.507 (0.556)
Const.		-1.732 (1.66)		1.148** (0.479)
<i>Chi-stat</i>		91.87***		131.84***
<i>No. of obs</i>		3,038		3,153
<i>No. of hhs</i>		2,251		2,309

[†] Standard errors clustered at the household level; p-values in brackets; *, ** and *** for significance at 10%, 5% and 1% levels ^{††} The fixed-effect is implemented using xtreg fixed effect command of stata with robust standard error, ^{†††} Within R^2

Similar to Table 7.10, more precipitation, which means higher income, leads to higher risk aversion and lower loss aversion, whereas higher wind speed, which means lower income, leads to lower risk aversion and higher loss aversion. Households display behaviours in accordance with prospect theory: they become more risk averse in the gain domain and risk seeking in the loss domain. These behaviours are consistent whether we use random or fixed-effect models. The effect of gain domain is reducing but insignificant for loss aversion, whereas the increasing effect on loss aversion of the loss domain is highly significant and large in both low and high stake lottery. By specification, loss aversion is only triggered when people are in the loss domain. Interestingly, while people living in areas with higher probability of typhoon are more risk averse, they significantly become less loss averse in both lottery A and B.

7.7. The Shifts of Reference Points Imputed for the PT Framework

In section 7.6, in contrast with the prediction made by PT, natural disasters significantly affects the risk preferences even after controlling the income effect. This evidence provides support for the background effect predicted by EUT. However, EUT is not supported because of the strong evidence on the presence of loss aversion. If people make decisions with regards to a reference point proposed by PT, the change in observed risk behaviours is likely due to a change in the reference point. This section describes the procedure to impute reference points using the PT framework, and then presents the empirical results on the shifts in reference points.

7.7.1. Imputation of Reference Points

We assume the curvature of the utility function to be stable, and allow other behavioural parameters to change. A shift in reference points leads to changes in values of prospects. Loss aversion is the change in behaviour when DMs switch from the gain to the loss

domain. In fact, as loss aversion measures the steepness of the utility when it changes from the gain to the loss domain (Abdellaoui, Bleichrodt, & Paraschiv, 2007; Kahneman & Tversky, 1979); we consider loss aversion only when changes in the reference point leads to a change from gain to loss domain. In the following section, we focus on measuring changes in the reference points for the lottery question only.

We define the value function $v_j(x|R_{jt})$ for prospect x of respondent j at time t as:

$$v_j(x|R_{jt}) = \begin{cases} U(x-R_{jt}) & \text{if } x \geq R_{jt} \\ -\delta U(R_{jt}-x) & \text{if } x \leq R_{jt} \end{cases} \quad (7.13)$$

where $U(.)$ is a concave, twice differentiable and non-decreasing utility function, δ is the loss aversion parameter. For a lottery with k prospects, we assume these prospects to be separable and additive so that the overall value derived from the lottery for respondent j is:

$$V = \sum_{i=1}^K \omega(p_i) v_j(x_i|R_{jt}) \quad (7.14)$$

where $\omega(p_i)$ is the probability weighting function that satisfies the properties of Kahneman and Tversky (1979) probability weighting function.

The value function in (7.13) can be converted to the value function where the reference point is equal to nil (the status quo assumed by Tversky and Kahneman, 1992) as follows:

$$v_j(x|R_{jt}) = v_j(x - R_{jt}|0) \quad (7.15)$$

for all values of R_{jt} .

The above framework is applied for the same notations of λ as the amount of willingness to pay (WTP) and Z as the maximum pay-off of the lottery with probability p in the lottery question. Assuming that the respondent views the prospect of winning nothing similar to the prospect of winning the amount at the reference point $v_j(0|R_{jt}) = v_j(R_{jt}|R_{jt}) = 0$, we have the following derivation of the WTP for the lottery:

$$v_j(\lambda|R_{jt}) = \omega(p) v_j(Z|R_{jt}) \quad (7.16)$$

Using this derivation, we prove that when we observe $0 < \lambda < Z$, the reference point must lie to the left of both λ and Z . Specifically, we have for $\lambda < Z$:

$$v_j(\lambda|R_{jt}) < v_j(Z|R_{jt}) \quad (7.17)$$

From (7.16) and (7.17), we have

$$(\omega(p) - 1)v_j(Z|R_{jt}) < 0 \quad (7.18)$$

Since $\omega(p) - 1 < 0$, we have from (7.16) $v_j(Z|R_{jt}) > 0$. By definition of the value function in (7.15) we have $Z > R_{jt}$. We similarly can prove that when we observe $\lambda > Z$ the reference point must lie to the right of both λ and Z .

For a set of values $\{\lambda; Z; p\}$ we can apply (7.15) for the lottery question as below

$$V = \begin{cases} \omega^+(p)U(Z - R_{jt}) & \text{if } \lambda < Z \\ -\omega^-(p)\delta U(R_{jt} - Z) & \text{if } \lambda > Z \end{cases} \quad (7.19)$$

We subsequently prove that a higher amount of WTP for the same lottery by the same respondent is associated with a positive increase in reference points (a shift to the right).

Figure 7.5 illustrates this right shift of reference points in the gain domain.

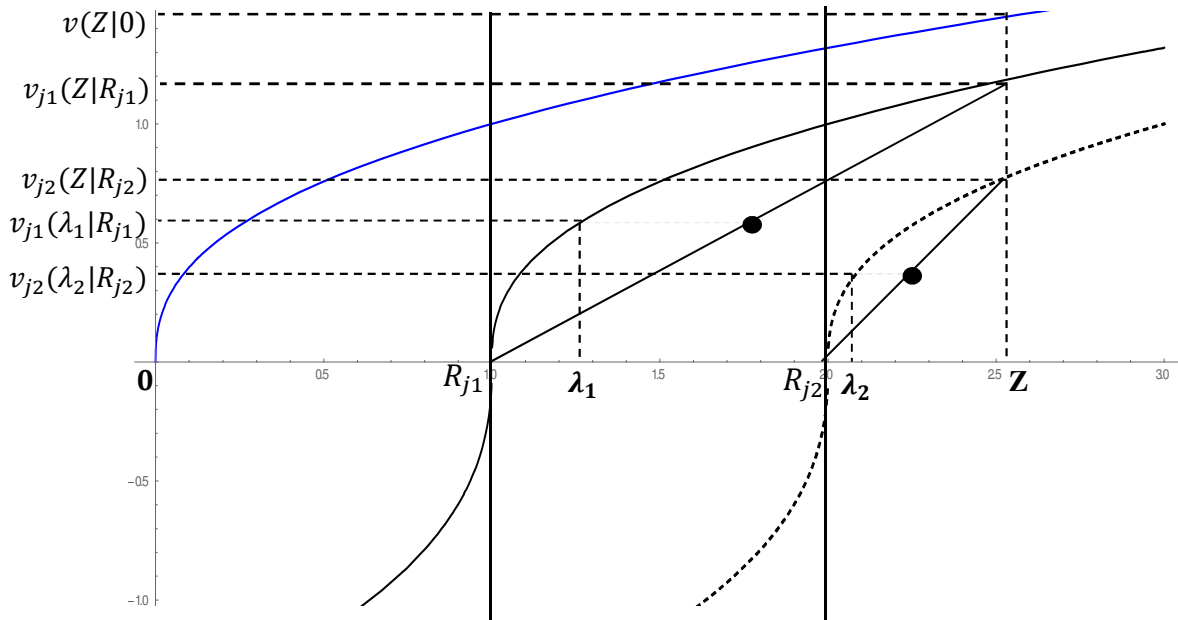


Figure 7.5: Shift of reference points in the gain domain

In this situation, we prove that between the two survey time $t=1$ and $t=2$, the change in the amount of WTP for the same lottery by the same DM can be attributed completely to the shift in the reference point, rather than the change in the shape of the utility function. Specifically, for the same preference set of DM j , if $\lambda_{j1} < \lambda_{j2} < Z$ then from the proof above we have $R_{j1} < \lambda_{j1} < \lambda_{j2} < Z$ and $R_{j2} < \lambda_{j2} < Z$.

From (7.17) we have

$$V_{j1} = \omega^+(p)U(Z - R_{j1}) \quad (7.20)$$

$$V_{j2} = \omega^+(p)U(Z - R_{j2}) \quad (7.21)$$

Assuming that the WTP is the certainty equivalence of the lottery, we have $V_{j1} = U(\lambda_1 - R_{j1})$ and $V_{j2} = U(\lambda_2 - R_{j2})$. From (7.20) and (7.21) we have the following derivation

$$\frac{U(\lambda_1 - R_{j1})}{U(\lambda_2 - R_{j2})} = \frac{U(Z - R_{j1})}{U(Z - R_{j2})} \quad (7.22)$$

Given the monotonous, non-decreasing iso-elastic utility function $U(\cdot)$ we further assume that $\frac{U(a)}{U(b)} = U\left(\frac{a}{b}\right)$ for $a > 0, b > 0$. From (7.22) we have

$$\frac{\lambda_1 - R_{j1}}{\lambda_2 - R_{j2}} = \frac{Z - R_{j1}}{Z - R_{j2}} < \frac{\lambda_2 - R_{j1}}{\lambda_2 - R_{j2}} \quad (7.23)$$

After re-arranging (7.23) we have

$$Z(R_{j2} - R_{j1}) > \lambda_2(R_{j2} - R_{j1}) \quad (7.24)$$

By definition we have $Z > \lambda_2 > 0$, therefore $R_{j2} - R_{j1} > 0$ or $R_{j2} > R_{j1}$. A similar result can be obtained when the shift in reference points is in the loss domain and when reference points shift between gain and loss domains.

Given the specification for (7.19) we can impute the reference points from the WTPs of the same household to lotteries A and B in the years 2010 and 2012 assuming a stable

curvature parameter. We assume $\omega^+(p) = \omega^-(p) = p$ and a power utility function. We further assume that individuals have the same reference point in the year where they make the choice for both Lottery A and Lottery B. The difference between the two risk aversion levels is purely due to the order effect (Holt & Laury, 2005).

We solve the following set of simultaneous equations for two reference points and one curvature parameter for each household who participated in the lottery game in two years and had positive WTPs for lottery A λ_{2010}^A and lottery B λ_{2010}^B that were less than the maximum payoff Z :¹⁵

$$\begin{cases} (\lambda_{2010}^A - R_{2010})^\alpha - p(Z^A - R_{2010})^\alpha = 0 \\ (\lambda_{2010}^B - R_{2010})^\alpha - p(Z^B - R_{2010})^\alpha = 0 \\ (\lambda_{2012}^A - R_{2012})^\alpha - p(Z^A - R_{2012})^\alpha = 0 \end{cases} \quad (7.25)$$

The above set of equations are subject to the condition that $\lambda^A < \lambda^B$ to satisfy the characteristics of the utility function $U(\cdot)$ because $Z^A < Z^B$. An alternative set of equations to estimate both loss aversion, UPC α and Rx is not supported by the data, which supports our previous observation that loss aversion is highly unstable¹⁶.

Our imputed reference points comprehensively capture the changes in WTP amounts: a higher WTP is associated with a higher value of reference points. Interestingly, the distributions of the imputed reference points tend to centre on the 0 value, which supports the ‘status quo’ hypothesis by Tversky and Kahneman (1992) and other empirical evidence on the tendency to evaluate lottery in isolation.

¹⁵ For a DM that participated in the lottery game for both years 2010 and 2012, we can estimate three other values of reference points. The characteristics of these reference points are similar and therefore not presented.

¹⁶ The DM is loss neutral if the accepted loss in the 50:50 game is 6: $loss = 6$. For $Rx < -loss$, we have the value of the 50:50 games equals: $0.5(6 - Rx)^\alpha + 0.5(-loss - Rx)^\alpha > 0$ for all possible values of loss (≥ 0). Therefore the person should accept all ranges of loss and the maximum value of Rx is -7. For $Rx > 6$, we have the value of the 50:50 games equals: $-\delta 0.5(Rx - 6)^\alpha - \delta 0.5(Rx + loss)^\alpha < 0$ for all possible values of loss (≥ 0). Therefore the person should reject all ranges of losses. However, we find 1,112 observations who participated in the lottery, have $Rx > 6$ but accepted losses > 0 .

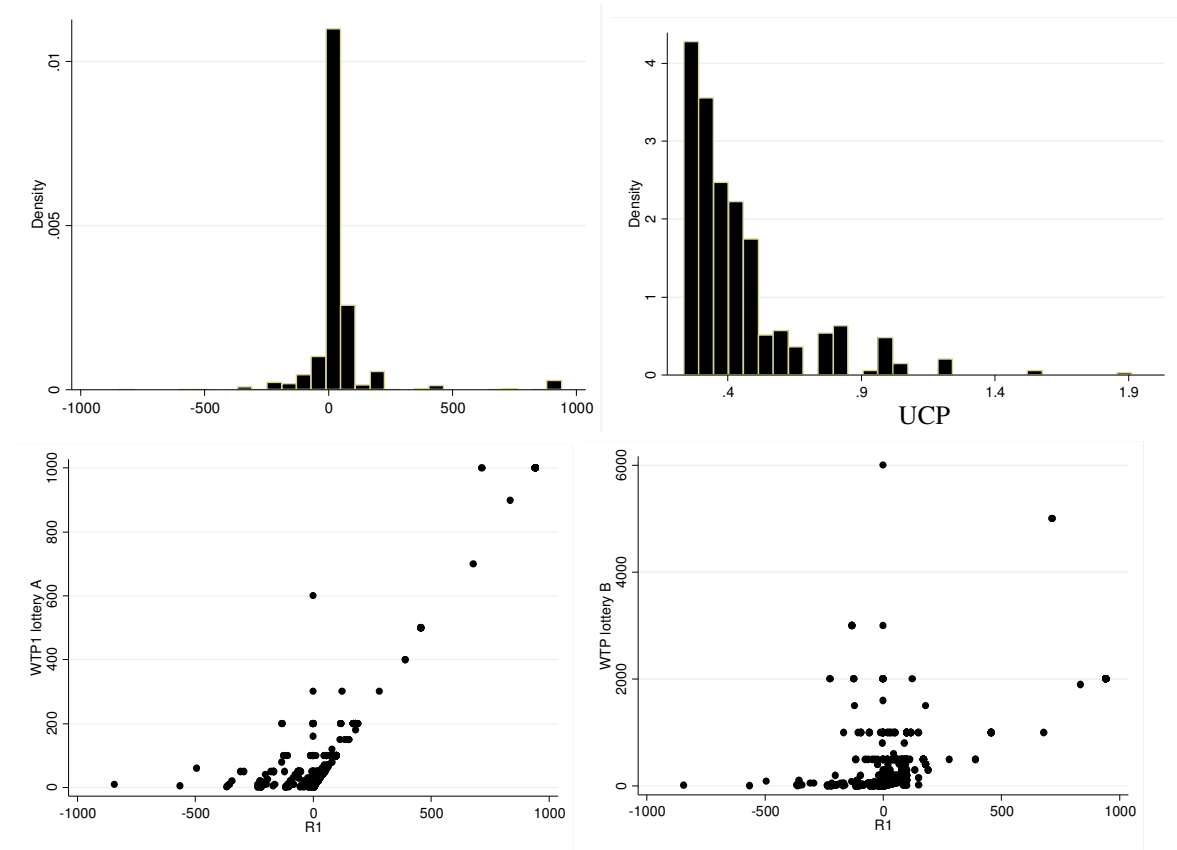


Figure 7.6: Distribution of imputed reference points

7.7.2 Empirical Evidence on the Shift in Reference Points

In this section, we present evidence on the change in risk preferences that are represented by the shifts in our imputed reference points (Table 7.12). We assume that the utility shape is stable, thus the curvature parameter UPC is constant, but the reference points for the same household are not stable. The specification models used to analyse the variations in UPC between households and shifts in reference points in both within and between households are similar to (7.5), except that our values of UPC and IMR are different, so as to account for a new sample of data. The sample used for this section's estimation participated in both years of survey. Therefore, we are able to perform both random effect, which uses both within- and between-household variations, and fixed effect, which uses

only within-household variations, to analyse the shifts in reference points. We can however, perform only random effect analysis on the UPC.

Table 7.12: Effect of weather shocks on UCP and shifts in reference points[†]

Panel A	Dependent variable: UCP in power utility function – Random effect	
	All sample	Sub-sample ^{††}
<i>Characteristics</i>		
Household size	0.005 (0.006)	0.006 (0.0045)
Health shock	0.103 (0.133)	0.062 (0.1339)
Male	-0.01 (0.032)	-0.009 (0.023)
Kinh	-0.05 (0.048)	0.023 (0.028)
Education	0.003 (0.003)	-0.001 (0.002)
Age	-0.0005 (0.0008)	-0.0003 (0.0006)
Illness	0.064**(0.0267)	0.045**(0.0191)
Army	0.011 (0.022)	0.005 (0.014)
Married	-0.016 (0.031)	-0.005 (0.023)
Interviewer effect included but not reported		
<i>Shock effect</i>		
IV income	0.006*** (0.002)	0.001 (0.001)
Precipitation	0.005 (0.003)	-0.004** (0.002)
Wind speed	0.076** (0.032)	-0.0004 (0.014)
Typhoon Probability	-0.234*** (0.043)	-0.115*** (0.032)
IMR	0.014 (0.18)	-0.156 (0.124)
Const.	0.256 (0.34)	0.706*** (0.231)
R^2	0.142	0.137
No. of obs	1,188	1,128
No. of hhs	594	564
Panel B	Dependent variable: Reference point	
	Fixed effect	Random Effect
<i>Characteristics</i>		
Household size	-1.3 (7.7)	9.1*** (3.3)
Health shock	-296.6 (231.7)	-105.1 (64)
Male	-28.3 (28.5)	-5.7 (15.3)
Kinh		56.3*** (17.5)
Education	7.5* (4.4)	-1.1 (1.3)
Age	1.7 (1.7)	-1** (0.4)
Illness	15.9 (30.3)	-8.6 (17.1)
Army	26.9 (24.4)	24.7** (10.5)
Married	4.7 (37.1)	-1.4 (13.5)
Interviewer effect included but not reported		
<i>Shock effect</i>		
IV income	-12.9** (6.4)	-0.9 (0.8)
Precipitation	-3.9* (2.1)	-7.9*** (1.3)
Wind speed	74.8** (37.5)	27.8* (15.8)
Typhoon probability		9.2 (19.3)
IMR	-143.7 (239.9)	123.8 (96.3)
Const.	186.9 (440.3)	-187.5 (186.6)
R^2 within	0.167	0.161
No. of obs	1,188	1,188
No. of hhs	594	594

[†]The fixed-effect and random effect are implemented using xreg fixed effect and random effect command of stata with robust standard error *, ** and *** for significance at 10%, 5% and 1% levels ^{††} Excluding risk-loving and risk neutrality

Table 7.12A shows that the UPC is not determined by individual and household characteristics except for the state of being ill. Sick people are found to be less risk averse. The shock effects are also less significant. The income effect is as expected with inclusion of risk neutral and risk-seeking observation. Exclusion of these observations provides supports for CRRA hypothesis with no significant income effect on risk aversion. Households in the area with high probability of the typhoons are more risk averse. We similarly find that households are risk seeking in the loss domain and risk-averse in the gain domain and the risk-seeking behaviours are strongly associated with people in the area with higher wind speeds.

Table 7.12B –Fixed effect model-considers only the within-household variations in explaining the shift in the imputed reference points. The high stability of household and individual characteristics leads to the insignificant effect of most variables, except for education and gender. Higher education leads to an increase in reference points and thus households behave in a less risk averse way. The income effect of typhoons unexpectedly increase reference points when income is reduced by typhoons. In accordance with previous results, the increase in precipitation decreases reference points and the increase in wind speeds increases reference points. These effects similarly are strongly driven by risk-neutral and risk-seeking behaviours. Table 7.12B –random effect model-considers both within- and between-household variations in explaining shifts in reference points. The characteristics become highly significant. Individuals who live in a large family, who used to be in the army and are not part of an ethnic minority have higher reference points than others. Older individuals have lower reference points. More education reduces the reference points but the effects are not significant. Sick people are not different from other people in risk behaviours. The adverse income effect of typhoons and the background risk of typhoon

probability have no effect on the imputed reference points. However, we consistently find that households increase reference points in loss domain proxied by wind speeds and decrease reference points in the gain domain proxied by precipitation.

As demonstrated, the shift in reference points closely tracks the effect of shocks on risk aversion observed in the previous sections. The analysis shows that previously observed changes in risk preference are well reflected in the shifts of reference points, assuming preference, in this case UCP, to be stable. Therefore, the *De Gustibus* assumption can well be established.

Table 7.12 shows that a person with higher income does not always increase his/her reference points and behave in a less risk averse way. Indeed the experiment by Gamba, Manzoni, and Stanca (2014) showed that subjects tend to behave in a less risk-averse way when they perceive their earning status lower than their peers. In that case, the income effect is negatively correlated with the reference point shift. Reference points therefore can be determined by social comparison. We test this hypothesis using the fixed-effect threshold method by Wang (2015). To proxy for the social comparison, we estimate the relative income ratio as the percentage of the average provincial income from the sample. The higher this ratio the better off the household is compared to other households in the same province. We then apply the fixed-effect regression in Table 7.12B to identify the relative income threshold where households display a change in behaviours. Table 7.13 shows that for all four sets of imputed reference points, there is always a range of relative income where households tend to shift the reference points upwards, and behave in a less risk-averse way, when their relative income is lower. Above and under this range, households behave in accordance with the rational expectation that the lower the relative income, the lower the reference point and vice versa. We also notice that the further above

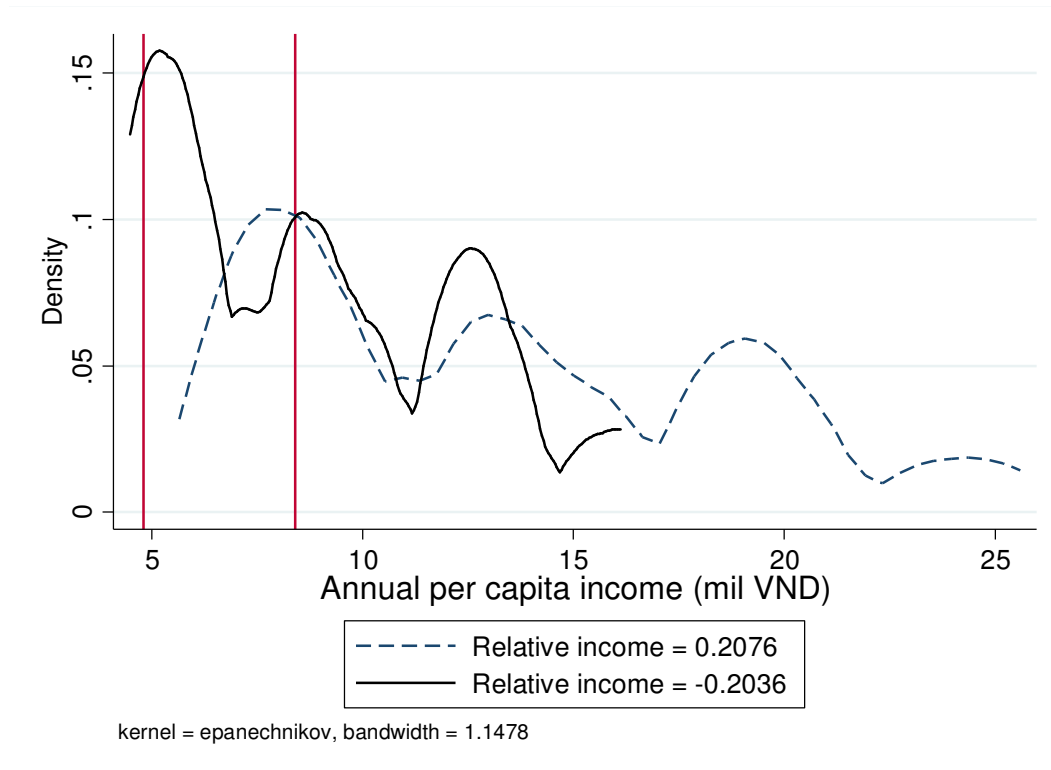
or under this range the relative income is, the smaller the distance of the reference point shift. This means that for very high or very low incomes, the reference points tend to stay quite stable.

Table 7.13: Fixed-effect panel threshold estimation for behaviour switch in reference point

<i>Relative income*</i>	No. of hhs – '10	No. of hhs – '12	No. of obs – '10	No. of obs – '12	Dependent variable: Reference point – fixed effect
≥ 0.5892	465	511	89	98	6.38 (5.37)
0.5892 to 0.2076	370	340	57	60	46** (21.9)
0.2076 to -0.2036	658	663	132	131	-65.6** (33.3)
-0.2036 to -0.5463	862	846	174	195	43.3 *** (16.1)
<-0.5463	682	677	103	110	15.4 (10)
<i>Other characteristics included but not reported</i>					
R^2 within	0.234				
No. of obs	1,110				
No. of hhs	555				

*Relative income = per capita income/ average provincial per capita income – 1; The sample excludes observations with UCP>1 so that inference is made from those with risk-averse UCP or those in the gain domain.

When we convert the range of relative incomes where households display a negative relation between reference point shifts and relative income into per capita incomes, we find the income distribution scattering around the poverty levels set by the Government (Figure 7.7). As can be seen, the counter-intuitive behaviours only occur among households who are near the poverty levels. Compared to other poor households, these household have the highest chance of moving upward to escape their poverty statuses. Presumably they are willing to take more risks to change their current income statuses than other households.



Two reference lines correspond to two poverty lines of monthly per capita income stipulated by Vietnamese Government for rural households (09/2011/QĐ-TTg for the period 2011-2015: 0.4 mil VND; 59/2015/QĐ-TTg for the period 2016-2020: 0.7 mil VND)

Figure 7.7: Distribution of per capita income range where behaviours switch in reference point

The evidence of social comparison as a determinant of reference point shift offers a reconciliation of the current conflicting evidence on stability of risk aversion after a natural disaster experience. The short-term effects of shocks in decreasing risk aversion can be explained by those who are temporarily knocked off the normal income statuses and therefore strongly driven to take risks to get back to their normal statuses. Over the long term these households recover and therefore display increased risk aversion. Future research with suitable data can test this hypothesis.

7.8 Conclusion

The lack of consistent empirical results on the impacts of shocks on risk preferences can be partly attributed to the reliance on one single measure of risk preference and inadequate identification of confounding effects. Using a panel dataset from rural Vietnam and a carefully calibrated set of weather shocks, we unpack this puzzle by simultaneously identifying both the wealth effect and the effect of changing background risks, differentiating between the gain and the loss domain, and distinguishing risk aversion from loss aversion. We show that the wealth effect of shocks is present and significant. Individuals are shown to display decreasing absolute risk aversion. Controlling for the wealth effect, we also find significant impacts of shocks on behaviours due to the background risk effect. However, the sign of the effect depends on the loss and gain domains. Our results are consistent with Kahneman and Tversky (1979), in that people become more risk averse and less loss averse in the domain of gain, but more loss averse and risk-seeking in the domain of loss. We show that both EUT and PT frameworks currently have shortcomings in explaining change in risk behaviour after shock experience. Because of this shortcoming, we develop a framework to impute the reference points from the responses to the lottery questions. We show that this framework is able to capture the behaviours of the farmers quite well, especially in response to the shock effect. Because of the shift in reference point, farmers behave in a less risk-averse way in the loss domain, and a more risk-averse way in the gain domain. We also find the effect of income and background risks on the reference points, but such effect is not consistent. Further investigation shows that a threshold exists where people with lower income status compared to the average income in their province will behave in a less risk-averse way by actively shifting their reference point upwards. Above and under this threshold, people with

higher or lower relative income will respectively increase or reduce their reference points. In general, we find that reference-dependent preference more flexible and worth pursuing in further studies on risk preference, especially studies on behaviours of poor rural households.

CHAPTER 8

Thesis Conclusion

8.1 Overview

Rural households in developing countries have been consistently shown to fail to smooth consumption against income shocks (Carter & Barrett, 2006; Dercon, 1998; Dercon & Krishnan, 2000; Krishna, 2010; McPeak & Barrett, 2001). The high dependence of rural households on agriculture often leaves them vulnerable to shocks related to agricultural production and the family's labour supply (Alderman & Paxson, 1992; Arouri, Nguyen, & Youssef, 2015; Berloff & Modena, 2013; Carter & Lybbert, 2012; Günther & Harttgen, 2009; Jalan & Ravallion, 1999; Lohmann & Lechtenfeld, 2015; Udry, 1994). Explanations include the limits of self-insurance (Pandey et al., 2007; Townsend, 1995), liquidity constraint and/or lack of access to credit (Amin, Rai, & Topa, 2003; Rosenzweig & Wolpin, 1993; Udry, 1994). For poor rural households, the options are further limited due to the vicious circle of low income and low assets accumulation. Development policies targeted at providing more insurance for these households have been recommended (Newman & Wainwright, 2011). However, not all policies, especially those related to development of agricultural insurance, have been adopted by the intended beneficiaries (De Bock & Gelade, 2012; Miranda & Farrin, 2012). Two issues need to be addressed in studying this puzzle. First, it is important to evaluate the impact of different kinds of shocks and the coping strategies used by farmers in response to these kinds of shocks. Farmers will not benefit from risk management policies targeted at shocks that are insured by current risk-coping strategies. As commented by Heltberg et al. (2015):

“studies finding that idiosyncratic risk is less burdensome and better managed than systemic risk would imply that policy should focus on systemic risk... In contrast, studies finding that idiosyncratic shocks are more frequent and costly compared to

systemic risk imply a more acute need for policies to help people manage idiosyncratic risk” (p.210).

Second, it is important to understand the role played by the risk preference of farmers when they are exposed to income shocks. Changes in the risk attitudes after experiencing income shocks may be the key to the puzzling responses of farmers to development policies.

The puzzle in development economics necessitates a more flexible framework to study behaviours of agricultural households and attracts an emerging literature (Carter, 2016). In relation to studies on risk-coping strategies, two notable developments are Asset Smoothing Theory to replace the traditional consumption smoothing theories and the Reference-Dependent preference to replace the Terminal Wealth preference in modelling choices under risk and uncertainty. Asset Smoothing Theory states that households are motivated to accumulate, rather than deplete, productive assets when income shocks occur (Zimmerman & Carter, 2003). The asset accumulation behaviour comes at the cost of reduced consumption, which directly violates the assumed aim of smoothing consumption by traditional theories such as Permanent Income Hypothesis (Friedman, 1957) and Complete Market Hypothesis (Cochrane, 1991; Mace, 1991). The Reference-Dependent preference states that a decision maker values a prospect with regards to a reference point, rather than combines the value of that prospect with his/her current wealth as often assumed in the Terminal Wealth preference. A family of Reference-Dependent preference has been developed (Kahneman & Tversky, 1979; Köszegi & Rabin, 2006; Quiggin, 1982) as alternative models to the Terminal Wealth model of Expected Utility Theory (Arrow, 1965; Pratt, 1964).

In this thesis, we empirically evaluate and compare the effect of covariate and idiosyncratic shocks, and the adequacy of risk-coping strategies in insuring agricultural households

against these shocks. We then evaluate the change in risk attitudes of the farmers after experiencing income shocks. Moreover, we link the empirical evidence on asset smoothing versus consumption smoothing behaviours and reference-dependent preference versus terminal wealth preference behaviours to the theoretical frameworks to provide better understanding of the primary motivation for such behaviours. The next section discusses the main findings of the thesis based on three hypotheses about the behaviours of the rural households in response to income shocks. Section 8.3 discusses the policy implication based on the main findings. The thesis ends with an evaluation of the limitation of the current study and suggestions for future research.

8.2 Research Findings

***8.2.1 Hypothesis 1:** Covariate shocks have a larger adverse impact on poor rural households than idiosyncratic shocks. The risk-sharing networks are triggered and effective when idiosyncratic shocks happen. However, such networks are ineffective when covariate shocks happen.*

In our sample, we consider four shocks common to agricultural households: floods, animal diseases outbreak, crop diseases outbreak and health shocks. Three shocks of floods, animal diseases and crop diseases are of a covariate nature because they affect a community rather than a specific household, whereas health shocks are an example of idiosyncratic shocks. Except for animal diseases, the other three shocks have negative effects on labour incomes of agricultural households. The most severe effect on income is from health shocks, followed by crop diseases and last by floods. Animal diseases increase income in the year of occurrence, which was attributed to the increase in the sale price of animal products (Tan, 2011) and the over-compensation (Hung & Duy, 2008). The lower effect of floods in reducing income compared to other shocks can be attributed partly to our construction of

this shock from weather data, rather than from perceived shocks. In doing that, we avoid the self-reporting bias of perceived shocks, but introduce the problem of basis risks where the weather data do not always relate exactly to the conditions experienced by households because of the geographical heterogeneity in the community (Elabed et al., 2013).

We find that households manage to smooth food consumption against health shocks, but fail to achieve consumption smoothing against other covariate shocks. We further find that agricultural households do possess a ‘portfolio’ of coping strategies in response to shocks (Morduch, 2004) and these strategies complement each other. In response to health shocks, households mostly rely on public and private transfers. In response to animal diseases and crop diseases households mostly rely on public transfers and additional credits as well as dis-saving. We additionally find that the informal financial transactions are more prevalent than formal transactions in rural Vietnam. However, when floods occur, we find a severe reduction in public transfers and private transfers and no responses of additional credits. The severe effects of floods in reducing external support have been documented previously in the literature (Fafchamps, 2003) and one main reason is the difficulty in delivering support to those in need due to the disruption caused by disasters. From the theoretical point of view, CMH predicts that covariate shocks are not insured, and only idiosyncratic shocks are insured. The reason is because covariate shocks affect everyone in the community and thus cause the risk-sharing network to collapse. In contrast, idiosyncratic shocks are not correlated and households can rely on the risk-sharing network to survive. The empirical evidence also refutes the assumption that weather shocks are transitory and explains the failure of previous PMH tests on rural households in developing countries that use this assumption.

8.2.2 Hypothesis 2: *Rural households are strongly motivated to smooth productive assets at the expense of reduced consumption to improve the income generation process when shocks happen. However, with the presence of labour markets, such behaviours may be replaced by the tendency to diversify into non-farm opportunities.*

Our tests of consumption smoothing show that health shocks are insured but other shocks are not insured. Consumption is reduced by crop diseases and floods. The results are the same whether we use the CMH or PIH tests. However, the assets smoothing tests developed by Carter and Lybbert (2012) corresponding to PIH test shows that assets are indeed smoothed by the sampled households. The assets balance shows a minor decrease when health shocks occur and a significant increase when crop diseases and floods occur. Asset smoothing behaviour has been predicted in the framework where formal credit markets are not available to rural households (Carter & Lybbert, 2012; Zimmerman & Carter, 2003). In our case, because of the development of an informal financial market, we are able to show that the motivation to smooth productive assets are so strong that they use the increased credit to invest in productive assets rather than make up for the short fall in consumption due to income losses. In reducing their food consumption expenditure, rural households increase their consumption of home-produced food when production shocks occur. This however can have a negative effect on the food market because of a reduction in food supply to markets when disasters occur.

With the presence of labour markets, rural households in Vietnam become pluri-active and engage in non-farm diversification. The most common non-farm diversification is waged activity but the surveyed households still rely greatly on agriculture. We find that non-farm diversification acts as a ‘curative’ strategy in response to income shocks. The asset smoothing behaviours are strongest among those who allocate most of their labour time to

agriculture, and least among those who spend most time off-farm. A threshold estimation of asset smoothing behaviours using the sample with non-farm diversification shows an asset threshold close to zero, which means that households without productive assets can rely on their labour skills to improve their livelihood. We notice a group of households with no skills and no assets. For this group, the responses of consumption to income are weak and consumption smoothing is supported. However, these behaviours are associated with very low levels of income and consumption and therefore reflect an existence of a poverty trap.

We also find that the non-farm activities reduce the perception of shocks among the rural farmers. In particular, the occurrence of floods is only reported by those who spend most time on agriculture, and not reported by those who diversify their activities off-farm. However, because the nature of non-farm diversification is in low skill jobs, not all who diversify are better off, especially when their skills as proxied by education levels are low. To further add to the problem, the occurrence of floods reduces the demand for casual labour, making it more difficult for the households with predominantly unskilled labour to respond to moderate income losses due to floods

These behaviours are confirmed when we consider regional heterogeneity. The North East region consistently lags behind other regions due to the low labour skills and high dependence on agriculture. Because of these two characteristics, the crops are mainly staples with low values, their asset bases are small and the income and consumption growth rates correspondingly are also very low. Notably, the public transfers are very high to this area, but the returns are low, which are visible not only through low per capita income, but also through the dwindling credit markets. In Centre South, despite being regularly exposed to natural disasters, households have better labour skills and engage more in non-farm diversification. The average per capita income and other development indicators of this

region are much higher than the North West region. The Central Highland and Mekong Delta have the highest per capita income of all rural regions. Farmers in Central Highland rely heavily on agriculture but they are among the most educated regions and make use of the rich soils to produce high cash crops. In this region, the assets used for agriculture are of relatively high values and asset smoothing behaviours are most evident. In Mekong Delta farmers can grow high value crops thanks to rich soils and larger production scales. However, the asset smoothing behaviours are not as evident in Central Highland as farmers have more non-farm diversification opportunities. Therefore, non-farm diversification is both a solution to rural development, and a problem when most non-farm diversification jobs in rural areas are of low skills and unstable.

8.2.3 Hypothesis 3: *The occurrence of shocks changes risk preferences of the poor rural households.*

It has been traditionally assumed that the reduced income due to shocks will make households more risk averse and thus trapped in the vicious circle of low investment and low income. The measurement of risk aversion among poor rural households is challenging as the observed behaviours may be confounded with market imperfections. The hypothetical survey of risk preferences therefore has several advantages over other risk attitude elicitation methods. Using a set of hypothetical survey questions of risk attitude, we find evidence supporting the income effect of shocks on risk attitudes. Farmers become more risk averse when income is reduced by typhoon occurrence. In addition, we find that controlling for the income effect, the background risk of typhoon occurrence makes households more risk averse. Using two weather variables of precipitation and wind speed, we further show that households display changes in risk behaviours in accordance with

Prospect Theory. Households are risk averse in the gain domain and risk-seeking in the loss domain.

Analysis of the risk behaviours highlights two issues. First, the current frameworks of Expected Utility Theory (EUT) and Prospect Theory (PT) display shortcomings in explaining behaviours of DMs when natural disasters occur. EUT can explain the background risk effect, but not the loss aversion. The PT can explain the loss aversion but not the background risk. Second, stable preference is the required assumption to conduct economic analysis. The measured risk attitudes using current EUT and PT frameworks show that risk preferences are highly stable. Assuming stable preference, we propose a new method of analysing risk attitude using shifts in reference points. We find that the instability in risk preference parameters can be explained by shifts in reference points. This reference point framework is highly flexible and allows us to analyse different risk behaviours. Using the proposed reference point framework, we find that social status is very important in determining the risk behaviours of the households. Specifically, households that are near the poverty threshold display a switch in behaviours: the lower their income status relative to the community average is, the higher they shift their reference points up and thus behave in a much less risk-averse manner. Our interpretation is that these households view themselves in the loss domain and strive to recover to the desired social status. However, such a switch in behaviours only applies for households within this range. Households that have very low incomes or very high incomes will behave in accordance with the intuitive expectation. The higher the relative incomes, the higher the reference points are.

8.3 Policy Implications

An understanding about the rural economy and the motivation for rural behaviours is important to the design of development policy. The empirical evidence shows that in rural areas, the covariate shock, especially natural disasters, has the most severe effect. Not only incomes but also risk-sharing networks are affected. The response of consuming home production by rural households makes it worse for market operation. It is necessary therefore to develop suitable policies to address the consequences of covariate shocks. Since informal finance and social networks play an important role in the livelihood of rural households, development policy should be directed towards employing this characteristic. In particular, investment in upgrading current risk-sharing networks should be promoted, especially those that provide timely support to farmers without distorting market operations.

In addition, it is worth noting that households can display risk-seeking and loss-averse behaviours in the loss domain when an income shock is experienced. The development of formal insurance markets will be met with unexpected demands despite the lack of coping strategy for covariate shocks. Instead, the development of appropriate strategies that provide incentives for rural households to improve their productivity is more feasible. With suitable motivations, farmers are shown to pursue asset smoothing strategies to smooth their future incomes.

In all scenarios, the innate ability of the farmers plays the central role in determining the success of a policy. Investments and transfers will all fail if the receivers are not motivated to exploit these opportunities. Lybbert and Wydick (2016) proposed that aspirations play an important role in the success in overcoming poverty. Duflo (2012) found evidence that poor households refused external support because they were not confident in their ability.

Similarly, in our studies, there always exists a threshold where behaviours are found to bifurcate. Employing this bifurcation point is strategic to the development of future policies. In particular, the chance of escaping poverty motivates risk-taking behaviours among households near the poverty line rather than those in very low income levels. Households that are near asset threshold will actively accumulate assets to smooth incomes. For those without productive assets, the ability to engage in non-farm diversification is strategic to future development. However, the benefit of non-farm diversification is subject to the returns from these jobs. Non-farm diversification should be associated with high-skilled and secure incomes. The investment in skills training and the development of a more active labour market should be given a priority in the rural development policy.

8.4 Limitation and Future Research Direction

In order to accommodate the tests of different theories we use observable shocks rather than unobserved shocks. It is possible that the effects of other shocks have not been captured. Future research can combine the two approaches to measuring shocks to achieve more comprehensive findings. In addition, our analysis of risk preferences is challenged by the complications in studying risk preferences from observed risk behaviours. Future studies can expand the current design of risk attitude elicitation questions to allow for more complex behaviours with a more comprehensive data set. Specifically, our preliminary development of reference point imputation in PT framework can be modified to allow for more parameters of risk preferences, for example loss aversion and probability weighting function. Finally, further research with the appropriate data can be undertaken on the question of designing an effective formal support network in the face of economic growth and change, and the role of risk preferences in the formal insurance market uptake in rural areas of developing countries.

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Appendix 1: Consumption of home production

	Per capita food consumption growth -CMH test		Log per capita food consumption -PIH test
Total self-consumption	(1)		(2)
		Permanent income	0.745**(0.02)
Floods	0.131*** (0.01)	Income effect due to floods	-2.566** (0.03)
Animal diseases	-0.049*** (0)	Income effect due to animal diseases	-1.687 (0.13)
Crop diseases	0.332*** (0)	Income effect due to crop diseases	-8.117*** (0)
Health shocks	-1.154 (0.19)	Income effect due to health shocks	0.775* (0.09)
<i>HH characteristics included but not reported</i>		Unexplained income	0.248*** (0)
Constant	-0.519 (0.65)	Constant	-6.813** (0.02)
No. of HH	1,915		1,915
R ²	0.12		0.66
Crop consumption (maize potato)	(1)		(2)
		Permanent income	-0.189 (0.47)
Floods	0.149*** (0)	Income effect due to floods	-4.07*** (0)
Animal diseases	-0.01 (0.21)	Income effect due to animal diseases	0.826 (0.19)
Crop diseases	0.081 (0.34)	Income effect due to crop diseases	-1.276 (0.37)
Health shocks	-0.534 (0.48)	Income effect due to health shocks	0.225 (0.53)
<i>HH characteristics included but not reported</i>		Unexplained income	0.085** (0.04)
Constant	-1.172 (0.19)	Constant	1.734 (0.47)
No. of HH	1,915		1,915
R ²			0.72
Livestock and aqua consumption (meat, aqua and eggs)	(1)		(2)
		Permanent income	0.78** (0.02)
Floods	0.049 (0.33)	Income effect due to floods	-0.753 (0.52)
Animal diseases	-0.041*** (0)	Income effect due to animal diseases	-1.337 (0.23)
Crop diseases	0.335*** (0)	Income effect due to crop diseases	-8.203*** (0.00)
Health shocks	-0.65 (0.45)	Income effect due to health shocks	0.621 (0.17)
<i>HH characteristics included but not reported</i>		Unexplained income	0.255*** (0.00)
Constant	-0.446 (0.7)	Constant	-7.131** (0.02)
No. of HH	1,915		1,915
R ²			

*** p<0.001; **p<0.05; *p<0.1. Robust standard error. P-value in brackets

Appendix 2: Studies of the effects of natural disasters on risk preferences

No	Authors & Years	Population	Data time	Natural disasters	Shock variable	Measure of risk preference	Inc	Finding
1	Eckel, El-Gamal, and Wilson (2009)	352 New Orleans poor evacuees	2005-2006	2005 Katrina hurricane	Binary (experience)	Ordered lottery	Real	Decrease (but less after 10 months)
2	Van den Berge et al (2009)	222 Nicaragua farmers 100 Peruvian farmers	2007 2004	1998 Hurricane Mitch 1983 and 1997 Elnino floods and droughts	Binary (reported experience) Continuous (induced losses)	WTP for lottery HL ordered lottery	Hyp Real	Increase
3	Andrabi and Das (2010)	4,670 Pakistans	2009	2005 Earthquake	Continuous (GPS distance)	Ordered lottery	Hyp	Increase
4	Li, Li, Wang, Rao, and Liu (2011)	206 adults China 333 school teachers China	2008	2008 Snow-hit 2008 Wenchuan Earthquake	Binary (experience)	HL lottery with gain/loss Insurance& lottery purchase	Hyp*	Conditional on probability
5	Cassar, Healy, and von Kessler (2017)	334 Thai villagers	2009	2004 Asian tsunami	Binary (GIS map of affected village, reported induced financial damages, killed family member)	HL ordered lottery	Real	Increase
6	Becchetti, Castriota, and Conzo (2012)	380 Sri Lankans	2011	2004 tsunami	Binary (Induced damage)	Investment	Real	No effect
7	Bchir and Willinger (2013)	309 Peruvians	? cross section	Mudflows lahars	Binary (affected area)	Binswanger MPL		Decrease
8	Gloede, Menkhoff, and Waibel (2015)	2,048 Vietnam rural households 2,069 rural Thai	2010	Self-reported shocks	Continuous (shock impact, dispersion and surprise)	Willingness to take risk Lottery purchase	Hyp	Increase +
9	Ingwersen (2014)	11,891 Indonesian adults	2004-2005-	2004 Indian Ocean Tsunami	Binary (reported experience and induced losses)	HL ordered lottery	Hyp	Temporarily decrease but no effect after 5

No	Authors & Years	Population	Data time	Natural disasters	Shock variable	Measure of risk preference	Inc	Finding
10	Page, Savage, and Torgler (2014)	220 Australians	2009 2011	2011 Australian floods (Brisbane)	Continuous (distance of flood height, induced losses)	Lottery purchase	Real	years Decrease
11	Cameron and Shah (2015)	1,550 Indonesians	2008	Floods and earthquakes	Binary (reported experience) Discrete (reported number of shocks) Continuous (GPS distance, reported losses)	Binswanger MPL	Hyp	Increase
12	Said, Afzal, and Turner (2015)	384 Pakistanese individuals in 320 households	2011	2010 'historically rare flood'	Binary (flood cluster, reported experience) Discrete(number of reported floods) Continuous (% induced losses)	Binswanger MPL	Hyp*	Conditional on experience of floods
13	Hanaoka, Shigeoka, and Watanabe (2015)	3,221 Japanese households	2011-2012	2011 Great East Japan Earthquake	Continuous (seismic intensity)	WTP for lottery	Hyp	Decrease
14	Reynaud and Aubert (2013)	449 households in Vietnam	2012	Floods	Binary (reported experience) Continuous (induced losses)	Tanaka et al (2010) protocol	Real	Increase loss aversion coefficient No effect on curvature and probability weighting function coefficients
15	Chantararat, Lertamphainont, and Samphantharak (2016)	426 Thai farmers	2014	2011 Flood	Binary (GIS affected village, reported experience) Continuous (% induced losses)	Binswanger-based rice seeds	Hyp	Increase
16	Kahsay and Osberghaus (2017)	4,496 German households	2012 2014	2013 Christian storms	Binary (reported damage)	Willingness to take risk	Hyp	Decrease

* Show-up fee applies

+Factor analysis shows first shock factor decreases risk aversion in Vietnam