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Essays on Applied Microeconomics and Development:

Income Risk, Income Shocks and Household Financial Decisions:

Evidence from rural Vietnam

by

Fiona Wainwright

Thesis submitted to the Department of Economics

in fulfillment of the requirements for the degree of

Doctor of Philosophy

at the

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Declaration

I declare that this thesis has not been submitted as an exercise for a degree at this or any other university.

The authorship of this work is organized as follows: Chapter 1 is entirely that of the author; Chapter 2 is co-authored with Carol Newman and Chapter 3 is co-authored with Finn Tarp and Carol Newman. The author's specific contribution to chapters 2 and 3 includes the overall research idea, literature review, conceptual framework, empirical strategy and empirical analysis. The author received direct input from the aforementioned co-authors in relation to the overall context of the study, the refinement of the empirical specification and the contextual interpretation of certain empirical results. Where this work includes the unpublished and/or published work of others, this is duly acknowledged in the text.

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Summary

Income risk remains a significant obstacle to rural development. Even within a transitioning economy such as Vietnam which has a significant social safety-net, income shocks (for example, natural disasters, illness, pest infestation, livestock disease) can be a cause of poverty and ruin for rural agricultural households. This thesis uses micro-theoretical foundations to empirically investigate the relationships between each of 1) social capital; 2) income risk and 3) income shocks and their impacts on household capacity to develop within a rural Vietnamese context. More specifically, this thesis contributes to the development literature concerned with 1) the role of social capital and its association with positive household formal financial services demand outcomes; 2) the various risk-coping strategies employed by households to deal with categories of income shocks and how this impacts upon household asset holdings and food consumption and 3) the impact of income risk on household investment and savings behaviour and associated household profit impacts.

The data for each chapter are taken from the rich Vietnam Access to Resources Household Survey (VARHS) for 2006, 2008 and 2010 which was carried out in rural areas of 12 provinces of Vietnam producing a balanced panel of 2,045 households spread over 161 districts and 456 communes. The empirical strategy combines both panel and cross-sectional estimation techniques where appropriate.

Chapter 1 (sole author) examines whether social capital acts as a facilitator to the take-up of formal financial services. Household demand for formal savings, credit and insurance instruments are simultaneously estimated (allowing also for combinations of these) by applying a trivariate probit model in order to determine the likely barriers to participation. Further, an index measure of the strength of social capital is included to determine the extent to which any positive externalities associated with *informal* networks translate into increased demand for formal financial services. Principal results are suggestive of positive spill-over effects whereby strong social capital is associated with increased likelihood of participation in formal credit and insurance markets. Such positive demand effects are taken as some evidence that social capital may be serving to correct an information failure.

Chapter 2 (co-authored with Carol Newman) considers the principal risk-coping strategies employed by rural households to mitigate consumption shortfalls caused by adverse

idiosyncratic and covariant income shocks. Using micro-theoretical foundations it empirically examines the extent to which households smooth consumption intra-temporally in the face of categories of adverse income shocks, and explore how this depends on self-insurance instruments in the form of savings in various liquid assets and formal insurance contracts over time. Results indicate that consumption is insulated from adverse income shocks for some, but not all, households. In order to protect consumption, households deplete liquid assets, in particular financial savings, and accumulate credit. Public insurance and external transfers assist in preserving cash holdings over time for some households.

Chapter 3 (co-authored with Finn Tarp and Carol Newman) considers the effect of income risk on behaviour in the form of household investment and savings decisions. Using micro-theoretical foundations it empirically examines the extent to which exogenous covariant natural risk discourages households from ex ante investment in own-farm capital (for more risky farm production activities) while encouraging investment diversification in small enterprise capital (for less risky non-farm activities). Liquid savings decisions were also considered. A key result is that covariant natural risk acts as a deterrent to household investment in own-farm capital while encouraging non-farm non-productive investment diversification. This is most evident among the poorest households. Moreover, estimates of average marginal profit level effects show *over*-investment in liquid assets and non-farm capital relative to own-farm capital for all households. A corollary to this result is that households are *under*-invested in own-farm capital relative to profit maximizing levels. This result is also most pronounced for the poorest households facing covariant risk. Risk is also found to motivate savings in forms of non-productive liquid capital for poorer households.

Taken altogether, these results indicate that income risk does matter for rural Vietnamese household investment and savings decisions, profitability and future productive capacity - particularly for the poorest. Results also show households use a *mix* of income and consumption smoothing strategies. The thesis concludes that formal insurance has the potential to assist households in managing income risk. This would reduce the need for distress asset selling and for precautionary saving which would enable valuable household resources to be allocated more productively. Moreover, via an appropriate information channel, informal social networks may have the potential to facilitate a transition towards a more market oriented formal insurance solution to household risk management.

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Dedication

This thesis is dedicated in loving memory to my mother, Margaret Flanagan.
Her love, strength and support will always be profoundly missed.

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Chapter 1:

Social Capital and Household Demand for Formal Financial Services: Evidence from rural Vietnam

1.0 Abstract

Using cross-sectional household survey data from rural Vietnam, this paper examines whether social capital acts as a facilitator to the take-up of formal financial services. We simultaneously estimate household demand for formal savings, credit and insurance instruments (allowing also for combinations of these) by applying a trivariate probit model in order to determine the likely barriers to household participation. Further, we include a measure of the strength of social capital to determine the extent to which any positive externalities associated with informal networks translate into increased demand for formal financial services. Results are suggestive of positive spill-over effects whereby strong social capital is associated with increased likelihood of participation in formal credit and insurance markets. Such positive demand effects are taken as some evidence that social capital may be serving to correct an informational failure which should also be taken into account when formulating appropriate policy aimed at strengthening formal financial services outreach to rural areas.

1.1 Introduction

The concept of social capital and its role in the process of economic development has received much attention in the literature in recent years. Despite the inherent difficulties associated with reaching a precise definition of social capital, the consensus view postulates that it generates positive behavioural externalities which arise from shared norms, trust and values and which in turn arise as a consequence of social relationships, networks and associations.[1] This empirical paper identifies observable variables which we argue are plausible proxies for social capital and explores their composite impact on household demand for formal financial savings, formal credit and formal insurance within the context of rural Vietnam. Our analysis attempts to shed light on whether social capital generates positive externalities which translate into increased demand for formal financial services. We attempt

[1] See Fafchamps and Durlauf (2004) for an expansion of these ideas.

to establish whether the existence of social capital acts as an enabler towards the realization of the collective welfare benefits arising from household *formal* savings, credit and insurance provision.[2] Hence, our prior postulates that increased uptake of formal financial services facilitates a transition towards a first-best market oriented solution for household welfare outcomes and that social capital may be associated positively with this objective.

Against a macroeconomic backdrop of market-oriented reforms, the provision of formal financial services (especially credit services) for the rural poor remains a key policy challenge for the Vietnamese government. With strong projected growth rates in Vietnam's banking sector, rural penetration rates are relatively strong.[3] Furthermore, despite being one of the world's fastest growing developing economies Vietnam remains a poor country with an estimated 70 per cent of the poor living in rural areas and depending on agriculture for their livelihoods (Barslund and Tarp, 2008). Although the provision of formal credit to rural Vietnamese households has been met anecdotally with varying degrees of success, low income households can benefit through access to a broader range of financial services than just credit (Armendariz and Murdoch, 2005).

According to Zellner (2001), financial services can be used for 1) income and consumption smoothing and 2) income generation activities. Insurance, consumption credit and short term liquid savings can address the first category while investment credit and savings deposits that earn interest can target the second. As discussed by Bendig et al. (2009) and evidenced by Wainwright and Newman (2011), formal insurance and forms of savings are used as household ex post risk-coping devices. Moreover, with forced depletion of valuable liquid assets due to categories of adverse income shocks, financially distressed households are more likely to request forms of credit. The importance of access to formal financial services in the face of ex ante income risk and ex post income shocks adds further motivation to this study and is given specific consideration in our empirical analysis.

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[2] We do not observe explicit informal risk-sharing arrangements within the dataset. For a consideration of how informal community structures facilitate risk-sharing see: Rosenzweig (1988); Fafchamps (1992); Townsend (1994); Udry (1994).

[3] See: Asia Focus, Country Analysis Unit, Federal Reserve Bank of San Francisco (June 2011) for a discussion of Banking Reform in Vietnam. In support of this, the raw survey data suggest that 60-70% of communes have access to a bank.

Following the work of Putnam et al. (1993) it has been proposed that social capital is most important at intermediate levels of economic development. Fafchamps (2002) also discusses that the function of clubs and networks (as one dimension of social capital) is to broaden the range and speed of social exchange beyond the confines of personalized trust. However, he postulates that once a sufficiently high level of generalized trust has been achieved, clubs and networks are no longer necessary and wither away. Our application to the rural Vietnamese context provides us with a unique opportunity to study aspects of social capital at work within a transitioning economy. We construct proxies for informal networks, trust and social norms which we argue are plausible representations of social capital, and explore how they interact (through a composite index measure) with household demand for formal financial services. Although reliance on social capital to facilitate efficiency in economic exchange is considered a second-best solution, achieving a first-best approach to enhancing financial participation, particularly in rural areas, via legal institutions and the state is far from an actuality within a transitioning economy context (Fafchamps 2002). Hence, any positive externality arising from social capital, as evidenced through positive behavioural responses to financial services demand, should not be ignored by policy makers.

This paper contributes to the literature by applying a systemic approach to analysing the demand for formal financial services by simultaneously estimating rural households' demand for formal savings, formal credit and formal insurance using a trivariate probit model. Our work follows Bendig et al. (2009), Bendig and Arun (2011) and Kis-Katos (2007) but our point of departure is that we incorporate the role of social capital in this process. We proxy social capital in a composite fashion by incorporating measures of informal network participation, trust and social norms into an index representing the overall strength of social capital. [4]We attempt to identify whether this proxy for social capital acts as a financial services demand enhancer or inhibitor. We use a unique cross-sectional dataset from Vietnam, namely the Vietnamese Access to Resources Household Survey 2010, and augment this with lagged wealth and social capital measures.

[4] We emphasise that variables such as trust are not in themselves social capital but are hypothesised to give rise to social capital as a by product of informal group membership and other informal interactions. Hence we construct a composite index for social capital by combining all such constituent measures as defined by Fafchamps and Durlauf (2004). Further, in order to motivate this choice of composite index, we initially establish empirically whether a relationship exists between measures of informal networks and shared norms/trust as is hypothesised.

Our results suggest that social capital is correlated with an increased likelihood of participation in formal credit and insurance markets. Such positive demand effects associated with social capital are taken as evidence that shared trust and norms are correlated with positive behavioural effects and may therefore be serving to correct an informational failure regarding the benefits of access to formal financial services. Although we cannot infer from our results under what specific conditions these social structures directly give rise to beneficial demand outcomes, the presence of a reinforcing relationship between strong social capital and formal financial services demand should be taken into account when formulating appropriate policy aimed at strengthening formal financial services outreach to rural areas within Vietnam.

This paper is organized as follows: In Section 1.2 we describe the conceptual framework underlying the households participation decision in formal savings, credit and insurance markets. Section 1.3 describes the rural Vietnamese survey data and the main variables of interest. Section 1.4 describes the empirical strategy, Section 1.5 presents the empirical results and Section 1.6 concludes.

1.2 Conceptual Framework

Following the approach taken by Bendig et al. (2009) and Bendig and Arun (2011), we consider the interconnectedness of household demand for formal savings, credit and insurance instruments and the extent to which proxies for social capital impact upon these demands. We model actual demand by assuming that observed household participation in formal financial services corresponds directly to satisfied demand. Due to data constraints, we cannot determine precisely which households actually demand formal financial services but are excluded from receiving them and which households did not demand formal financial services even though they had access. It is also likely that differing supply side factors, such as collateral requirements or certain procedural differences specific to rural Vietnamese districts may lead to rationing in rural financial market restricting some households from using some services. We now consider the conceptual underpinnings of rural household demand for formal savings, credit and insurance instruments in turn and the role that we hypothesise social capital plays in this process. Although we hypothesise that social capital has a positive effect on the demand for formal financial services, it is important to emphasise

that informal networks may directly facilitate forms of informal group savings, credit and risk-sharing which could lead to negative *formal* demand effects.

1.2.1 Social Capital

Social Capital has been heralded as the glue that holds communities together yet this important concept remains empirically elusive (Stone et al., 2002). In order to derive a plausible representation for social capital within the context of rural Vietnamese households, it is necessary first to anchor our understanding of social capital within the literature. To achieve this we turn to Fafchamps and Durlauf (2004) who consult the leading researchers on social capital and provide a substantive definition from which they distinguish three main underlying ideas: (1) social capital generates positive externalities for members of a group; (2) these externalities are achieved through shared trust, norms and values and their consequent effects on expectations and behaviour; (3) shared trust, norms and values arise from informal forms of organizations based on social networks and associations. In this study we are particularly interested in understanding whether *informal* social networks (for example, reciprocity among Vietnamese village communities) generate beneficial outcomes (measured by increased demand for formal financial services) through shared norms and trust.

Authors such as Banfield (1958) and Fukuyama (1995) have described that low levels of trust toward others are generally associated with high levels of trust within subgroups, such as the family. According to Guiso et al. (2004), this lack of trust towards others leads naturally to move transactions from the market to the restricted family circle and they expect a high incidence of loans by friends and family in low-trust areas (thus a negative correlation between the likelihood of informal loans and the level of trust). In a developing context such as rural Vietnam, with its emphasis on the village as the cultural and social unit of the countryside (Nguyen Tuan Anh (2010)), we might therefore expect a *positive* correlation between the likelihood of formal loans and the level of trust towards others in a village setting. This hypothesis also extends to formal savings and insurance by applying the views of Guiso et al. (2004) who state that if trust matters, it should matter most for the development of financial markets. Thus, we are applying the key insights of Guiso et al (2004) (who find that households in high social capital areas make less use of informal financial services) to this study of a rural transitioning economy such as Vietnam. We

postulate too, that *informal* social capital should also matter for financial services demand outcomes given the existing study by Newman et al (2012) which specifically considers formal social capital in a similar context. Thus we seek to complement the existing study of formal social capital effects on formal savings by considering informal social capital and its effects on simultaneous formal savings, credit and insurance decisions. We must acknowledge that norms and trust are components of a more complex social system called social capital and the identification challenges which arise from this are discussed in more detail in the empirical section. It must also be emphasised, that this study can only speculate as to what underlying conditions may directly orient informal networks to generate positive (or negative) formal financial services demand outcomes.

1.2.2 Formal Savings

Savings are critical to households in developing countries (Ashraf et al., 2004). Access to suitable savings products can facilitate household risk-coping strategies in the face of adverse income shocks and can also facilitate household capital investment in own-farm and non-farm productive capability. Despite the importance of savings, Ashraf et al. (2004) argue that mobilization typically is considered low in developing countries, and that creating and implementing policies to raise it is difficult. Although this paper focuses primarily on household demand for formal savings instruments it is worth echoing Kendall (2011) by emphasising that the poor do most of their saving through informal options. According to Kendall (2011), the primary advantage of informal over formal savings options appears to be that informal options are available, whereas for many of the poor in the developing world, accessing formal financial tools is not realistic given the great distances they might have to travel and the high costs they would be charged. Informal savings are typically held in liquid form, for example, cash stored at home. Formal savings products are generally less accessible and may also suffer from a lack of flexibility whereby fixed interest rates may lose value in periods of high inflation, which has been the norm in Vietnam in recent years. Observed low formal savings rates might therefore be a consequence of poor access to safe, flexible, convenient, and affordable savings products.

Against this backdrop this paper explores whether the determinants of formal savings demand in a developing country context such as rural Vietnam differ from those of more advanced economies. More specifically, we explore whether the standard lifecycle hypotheses of savings behaviour are empirically supported. For example, strong family ties make it less

necessary to save for future retirement, and remittances appear to influence the timing of savings within the life cycle of a household (Spio and Groenewald, 1996). We echo Collins (2005) who states that the environment within which households operate in low-income countries makes the process of financial decision-making quite different from those in developed countries. Collins (2005) also states that the life-cycle hypothesis (Ando and Modigliani, 1963) does not hold for developing economies and cites that many researchers (Deaton, 1992; Spio and Groenewald, 1996) reject this hypothesis in most low income countries. He notes that savings appear to be precautionary and held for insurance reasons. In this paper we also assess the impact of both income risk and income shocks in the savings decision process.

Our analysis of the role of social capital in the formal savings decision process also considers that informal socialization may generate an economically useful information transfer in the form of an externality via shared norms and trust. This hypothesis is motivated in part by Kiiza and Pederson (2002) who show that the decision to hold a bank savings deposit in Uganda is positively related to the information available to the household on the respective banking system and in part by Newman et al. (2012) who discuss how households in rural Vietnamese communities often lack the information necessary to set up formal deposit accounts or are uncertain about the returns to saving formally. Indeed, Newman et al. (2012) explore the extent to which social networks in rural Vietnam can play a role in increasing formal savings and find that membership of high quality networks leads to higher levels of saving in formal financial institutions and to higher levels of saving for productive investments as compared with other precautionary or lifecycle motives.[5] Here, we complement the study by Newman et al. (2012) by focussing on participation in informal networks and proxies of trust and social norms. Further, we consider the household decision to save formally as an integral part of a composite financial strategy also covering formal credit and insurance participation decisions.

1.2.3 Formal Credit

Resourceful rural households in developing countries often maintain a *mix* of savings and credit instruments (whether informal or formal in origin). According to Morduch (2009), the pattern of borrowing while saving is a regularity in the "financial diaries" collected over a

[5] Newman et al. (2012) define networks as active membership of Women's Unions and the quality of networks is measured by the level of formal savings observed among group members.

year in villages and poor urban neighbourhoods in India, South Africa, and Bangladesh.[6] Morduch (2009) cites one possible explanation for borrowing while holding liquid assets sufficient to avoid debt is that individuals want to maintain the option to draw down savings while borrowing: by not touching saving, borrowers retain the possibility of dis-saving when additional liquidity is needed. Another possibility considered is that borrowing brings a *de facto* risk sharing element via limited liability while dis-saving and re-saving places all the risk on savers.

Given the important role of credit in developing economies, many demand analyses consider credit rationing in the markets for rural credit (Kochar, 1997) by combining the demand for both informal and formal borrowing. Barslund and Tarp (2008) use a survey of 932 rural households to explore how the rural credit market operates in Vietnam and discover that formal loans are almost entirely for production and asset accumulation, while informal loans are used for consumption smoothing. They conclude that the determinants of formal and informal credit demand are distinct and given regional differences a 'one size fits all' approach to credit policy in Vietnam would be inappropriate. We also investigate whether key variables affecting the demand for formal credit accord with the motivation to use a loan for investment purposes. Further, by specifically considering household formal credit participation responses to measures of income risk and income shocks, we investigate whether components of formal credit may also serve risk mitigation purposes.

Bastelaer (2000), in a review of the related micro-finance literature, suggests that the use of existing social ties improves the access of the poor to credit, but that they do so through various channels whose relative importance is subject to significant debate. He concludes nevertheless, that there is little doubt that social connections among borrowers in group lending schemes allow significant savings in screening, mutual monitoring and enforcement. Although not specific to group micro-finance lending, we test a related hypothesis within the context of formal credit market participation, where it could be argued that social ties are less effective. We hypothesise that our measures of social capital, which captures shared trust and norms, should generate a positive externality (through correcting an informational failure) which translates directly into enhanced household demand for formal credit instruments.

[6] The "financial diaries" to which Morduch (2010) references is compiled in: 'Portfolios of the Poor' by Daryl Collins, Jonathan Morduch, Stuart Rutherford and Orlanda Ruthven; Princeton University Press.

1.2.4 Formal Insurance

Recent literature suggests that the lack of insurance, both in terms of market availability and actual take-up, is one of the key drivers of persistent levels of poverty in developing countries (Morduch, 2002). Lack of insurance has adverse implications for welfare outcomes particularly in rural areas of Vietnam where the majority of low income households are engaged in farming-type activities, and are subject to material losses as a consequence of fluctuations in agriculturally derived income from external shocks such as drought, floods, pest infestation and livestock disease.[7] The purchase of a comprehensive insurance package, however, is a complex process (Showers and Shotick, 1994). Households evaluate their financial needs and determine various insurance schemes to insure against adverse income shocks. According to modern financial theory, a household should hold a diversified market portfolio that minimizes non-systematic risk. In practice, however, (and especially in developing economies) many idiosyncratic and covariate risks are not insured and households often remain exposed to movements in local weather, regional house prices, prices of commodities like rice, gasoline and heating oil and national income fluctuations. In the absence of well developed financial markets in developing countries, households tend to engage in costly informal risk mitigating strategies to reduce income fluctuations. For example, Morduch (1995) finds that Indian farmers near subsistence level spatially diversify their plots, and devote a larger share of land to low-yield traditional varieties of rice and castor. These income-smoothing activities can succeed in reducing the volatility of income, but at a very high cost.

In practice, markets for formal insurance instruments (in particular to protect against spatially covariant shocks) are not well developed within a developing country context. Consequently, the traditional view of social capital is to correct this market failure by facilitating informal risk-sharing arrangements which serve to compensate (to varying degrees) for lack of formal insurance market outreach. For example, Townsend (1994) using data from three high-risk villages in India, finds that household consumption co-moves with village average consumption and that once village level risk is controlled for, household consumption is not influenced by contemporaneous own income, sickness, unemployment, or other idiosyncratic shocks. Overall, the evidence suggests that informal risk-sharing arrangements remain

[7] For example Morduch and Sicular (2002) found that while average incomes in villages in the Shandong Province in northern China were growing at 8 per cent per year, one quarter of the population in any given year was suffering losses of about 20 per cent.

important. However there is also much evidence to suggest that informal risk-sharing is typically partial and inefficient and as a result expected utility is likely to increase under formal insurance arrangements (Cox and Jimenez, 1992). The ongoing debate regarding the persistence of informal risk-coping through strong social ties within rural communities in developing economies, together with the availability of data on formal insurance participation, presents a unique opportunity to examine whether strong social capital acts as an enabler or an inhibitor towards household demand for formal insurance within the rural Vietnamese context and to consider the underlying role of information in this process.

1.2.5 Simultaneous Demand

The functions of savings, credit and insurance are intimately connected with one another in most developing economies (Besley 1995, p.2126). Besley (1995) further discusses that by contrast, in a competitive economy with no externalities and with a complete set of Arrow-Debreu securities there is separability between decisions that transfer resources across time (savings and credit) and those that transfer resources across states of nature (insurance). Given that this theoretical construct is far from actuality within a developing country context such as rural Vietnam, separability of savings/credit from insurance breaks down when markets are incomplete. According to Besley (1995), it is the absence of an insurance possibility that motivates a savings opportunity. Hence, we treat a household's decisions in relation to savings, credit and insurance as simultaneous and driven by common unobservable factors such as household risk preferences.

Against this backdrop, an important component of our household demand analysis for formal financial services is the role of ex ante income risk and ex post income shocks in the household participation decision process. We would expect, in line with theoretical literature that risk averse households which have experienced income shocks or believe themselves to be exposed to significant income risk are more likely to take out suitable insurance contracts or save pre-emptively.[8] Households without formal insurance may seek credit or dis-save ex post as part of an overall risk-coping strategy. Within this context, we categorize income shocks as either idiosyncratic (for example injury, illness, etc.), that only affect an individual household, or spatially covariant (for example floods, drought), that affect all households in a

[8] Using the same dataset in a panel format from 2006 through 2010, Wainwright and Newman (2011) find evidence that both liquid capital and formal insurance are important risk coping strategies.

particular geographic location. Further, we proxy associated forms of income risk using lagged realizations of idiosyncratic and covariant shocks.[9]

1.3 Data Description

The data are taken from the Vietnam Access to Resources Household Survey (VARHS).[10] This survey was carried out in rural areas of 12 provinces of Vietnam between August and September 2010 thereby producing cross-sectional data on more than 2,300 households.[11] The VARHS explores issues surrounding Vietnamese rural households' access to resources and the constraints that these households face in managing their livelihoods. The households are spread over 161 districts and 466 communes. Along with detailed demographic information on household members, the survey includes sections on household savings, credit (both formal and informal), formal insurance, risk response, informal safety nets and the structure of social capital. The dependent variables for each household's formal savings, formal credit and formal insurance participation decisions are three binary representations which are each coded '1' if the household currently holds that financial instrument and coded '0' otherwise. A more detailed account of the econometric derivation of the dependent variables is provided in the Estimation Strategy, Section 1.4. A description of the main explanatory variables of interest together with the dependent variables is given in Table 1.1.

[9] Chapters 2 and 3 provide more details on incidences of income shocks across households. We also use the term covariant to describe shocks which co-vary across households within regions.

[10] The survey was developed in collaboration between the Development Economics Research Group (DERG), Department of Economics, University of Copenhagen and the Central Institute of Economic Management (CIEM), the Institute for Labour Studies and Social Affairs (ILSSA) and the Institute of Policy and Strategy for Agriculture and Rural Development (IPSARD), Hanoi, Vietnam.

[11] The VAHRS is in fact now a panel covering the same households in 2006, 2008 and 2010. This study of simultaneous household demand for formal financial services explores the 2010 data in a cross-sectional capacity.

Table 1.1: Main Variables and descriptions

Dependent Variable	**Variable Label**	**Description**
Formal Savings	S_i equations (1), (2)	Dummy variable indicating whether the household currently holds a formal savings instrument ('1' = Yes, '0'= 'No')
Formal Credit	B_i equations (1), (2)	Dummy variable indicating whether the household currently holds a formal credit instrument ('1' = Yes, '0'= 'No')
Formal Insurance	I_i equations (1), (2)	Dummy variable indicating whether the household currently holds a formal insurance instrument ('1' = Yes, '0'= 'No')
Explanatory Variable	**Variable Label**	**Description**
Exogenous: Covariant Natural Risk	Element of vector $\boldsymbol{X_i}$ equation (1)	*Proxy Variable:* Dummy variable indicating whether the household has suffered a spatially covariant natural income shock during period $t-2$ to period $t-1$. Such lagged ghocks include floods, landslides, typhoons, storms, droughts, pest infestation, crop disease and avian flu.
Exogenous: Covariant Economic Risk	Element of vector $\boldsymbol{X_i}$ equation (1)	*Proxy Variable:* Dummy variable indicating whether the household has suffered an exogenous economic shock during period $t-2$ to period $t-1$. Shocks include changes in crop price, changes in key input prices, changes in prices of food or other essential commodities consumed.
Idiosyncratic: Insurable Risk	Element of vector $\boldsymbol{X_i}$ equation (1)	*Proxy Variable:* Dummy variable indicating whether the household has suffered an idiosyncratic insurable income shock during period $t-2$ to period $t-1$. Shocks include illness, injury or death of a family member.
Idiosyncratic: Uninsurable Risk	Element of vector $\boldsymbol{X_i}$ equation (1)	*Proxy Variable:* Dummy variable indicating whether the household has suffered an idiosyncratic uninsurable income shock during period $t-1$to period $t-2$. Shocks include unemployment, unsuccessful investment, loss of land, crime/robbery/theft, divorce, family disputes.
Exogenous: Natural Shock	Element of vector $\boldsymbol{X_i}$ equation (1)	Dummy variable indicating whether the household has suffered a current period spatially covariant natural income shock.
Exogenous: Economic Shock	Element of vector $\boldsymbol{X_i}$ equation (1)	Dummy variable indicating whether the household has suffered a current period exogenous economic shock.
Idiosyncratic: Insurable Shock	Element of vector $\boldsymbol{X_i}$ equation (1)	Dummy variable indicating whether the household has suffered a current period idiosyncratic insurable income shock.
Idiosyncratic: Uninsurable Shock	Element of vector $\boldsymbol{X_i}$ equation (1)	Dummy variable indicating whether the household has suffered a current period idiosyncratic uninsurable income shock.
Not Recovered (Prior)	Element of vector $\boldsymbol{X_i}$ equation (1)	Dummy variable indicating whether the household has NOT recovered from income shocks suffered during period $t-2$ to period $t-1$.
Not Recovered (Current)	Element of vector $\boldsymbol{X_i}$ equation (1)	Dummy variable indicating whether the household has NOT recovered from income shocks in the current time period.
Private Transfers	Element of vector $\boldsymbol{X_i}$ equation (1)	Dummy variable indicating whether the household is in receipt of transfers from private sources during the current period.
Public Transfers	Element of vector $\boldsymbol{X_i}$ equation (1)	Dummy variable indicating whether the household is in receipt of transfers from public sources during the current period.
Wage Income (Log)	Element of vector $\boldsymbol{X_i}$ equation (1)	Wage income from all sources ('000 VND): (2010 mean = 116711 VND, 2010 std deviation=26497 VND)

Small Medium Enterprise	Element of vector $\boldsymbol{X_i}$ equation (1)	Dummy variable indicating whether the household has engaged in non-farm small enterprise activities during the current period.
Total Area Farmed	Element of vector $\boldsymbol{X_i}$ equation (1)	Lagged variable representing the total area farmed by the household in period $t-1$. Measured in hectares.
Wealth Group	Element of vector $\boldsymbol{X_i}$ equation (1)	Ordered variable grouping households into wealth groups of three categories: 1 Lowest Wealth Group, 2 Middle Wealth Group 4 Highest Wealth Group. Total household wealth constructed using fixed asset values (irrigation equipment, livestock, farm machinery), liquid asset values (savings, crop stores) and all consumer durables ('000 VND): (2010 mean = 56489 VND, 2010 std deviation=201607 VND)
Household Size	Element of vector $\boldsymbol{X_i}$ equation (1)	Total number of household members.
Education of Household Head	Element of vector $\boldsymbol{X_i}$ equation (1)	1 "Cannot read and write" 2 "Can read & write but did not finish primary school" 3 "Finished primary school" 4 "Finished lower secondary school" 5 "Finished upper secondary school" 6 "Third Level"
Age of Household Head	Element of vector $\boldsymbol{X_i}$ equation (1)	Measured in years.
Age Squared of Household Head	Element of vector $\boldsymbol{X_i}$ equation (1)	Measured in years.
Distance of household from nearest all weather road.	Element of vector $\boldsymbol{X_i}$ equation (1)	Measured in km.
Distance of household from nearest commune headquarters.	Element of vector $\boldsymbol{X_i}$ equation (1)	Measured in km.

We first explore the raw data on household savings participation. The data facilitate disaggregation of categories of saving across both formal and informal instruments. These data are presented in Table 1.2.

Table 1.2: Categories of Household Savings in 2010

	Percentage of Households
Total Savings	**72%**
of which	
Formal	**12%**
of which	
Postal Savings	4%
State owned commercial bank	66%
Private Bank	11%
Credit Organization	16%
Other	5%
Informal	**97%**
of which	
ROSCAs	15%
Cash/Gold/Jewellery at home	94%
Private moneylender	2%
Other	2%

The raw data reveal that although 72 per cent of households hold some form of savings device, only 12 per cent of these are held with formal financial institutions. By contrast 97 per cent of households (that save) report to save informally, with cash/gold/jewellery held at home emerging as the most popular informal mechanism for 94 per cent of these households. Of the households saving with formal financial institutions, 66 per cent use state owned commercial banks.

In addition to the data on modes of saving presented in Table 1.2, raw data indicate that of those households saving with formal financial institutions, 43 per cent report saving for big expenditures while only 12 per cent report saving for a profit making investment. Finally, while 6 per cent of all households hold savings with *both* formal and informal institutions only 2 per cent hold formal savings instruments *only* while a significant 64 per cent of all households rely only on informal savings mechanisms.

By contrast to the relative dominance of informal over formal modes of saving, the raw data reveal that while 45 per cent of households report to hold credit instruments, 69 per cent of these households hold credit with formal financial institutions with only 32 per cent (of households with credit) turn to informal sources. Table 1.3 provides a more detailed breakdown across categories of household credit.

Table 1.3: Categories of Household Credit in 2010

	Percentage of Households
Total Credit	**45%**
of which	
Formal	**69%**
of which	
Vietnam Social Policy Bank (VBSP)	63%
Bank for Agriculture and Rural Development (VBARD)	34%
Other State Owned Commercial Bank	4%
Local Authorities	0%
Private Banks	2%
Group	**9%**
Informal	**32%**

The dominance of formal over informal sources of credit can be in part attributed to the Vietnamese government's efforts to make more credit available to rural households. According to a report by Newman et al. (2011), formal credit is provided to households in

rural areas through two main state owned banks, the Vietnamese Bank for Social Policy (VBSP), which lends to the poor, and the Vietnamese Bank for Agriculture and rural development (VBARD), which lends on a commercial basis. This initiative has met with varying degrees of success. Anecdotal evidence suggests that while formal credit is widely available it is more often used for consumption than for productive investment purposes. The raw data presented in Table 1.3 provides some evidence in support of this whereby 63 per cent of formal lending originates from the VBSP with 34 per cent originating from the VBARD.

This study only considers household participation in voluntary insurance contracts and as such we exclude free social insurance for the poor, compulsory social insurance, free health insurance for children together with compulsory health insurance. The raw data indicate that 47 per cent of households surveyed hold some form of formal voluntary insurance contract. Of these, 11 per cent hold fire insurance, 15 per cent hold health insurance, 2 per cent hold education insurance and 89 per cent hold other unspecified contracts.[12] Among the distinct types of formal voluntary insurance listed in the survey, health insurance schemes have the highest participation rates. In contrast, there are no households in our sample that have agricultural insurance. The survey data from 2006 also reveal the reasons why households do not demand each type of formal insurance. Seven per cent of households are not aware of the existence of formal insurance products, 58 per cent state that they have no need for insurance while 18 per cent of households have no information regarding insurance products.

We are also interested in understanding the determinants of formal financial services participation for 1) households currently holding all three credit, insurance and savings instruments; 2) households holding no formal instruments and 3) households holding combinations of these. Table 1.3.1 provides a breakdown across relevant instrument groupings as a percentage of all households.

[12] For more details on formal insurance within the context of the VARHS data set see Wainwright and Newman (2011), Chapter 2 of this thesis.

Table 1.3.1: Percentage of all Households in 2010 holding Formal Financial Instruments (and combinations of these)

Insurance Only	Savings Only	Credit Only	Savings and Insurance Only	Savings and Credit Only	Credit and Insurance Only	Savings, Credit and Insurance	None
26%	2%	14%	4%	2%	15%	2%	35%

Raw data reveal that only 2 per cent of households hold all three formal financial instruments while 35 per cent of households report not to participate in any formal financial services markets. This result clearly illustrates the remaining scope for formal financial services penetration to rural Vietnamese villages. While data reveal that 26 per cent of households report to hold a voluntary insurance instrument to the exclusion of other formal financial services products, 15 per cent report to hold formal credit and formal insurance instruments only. Overall, these raw data reveal that although formal financial services participation rates remain relatively low, household demand is more concentrated between formal insurance and formal credit instruments. Finally, other raw data (not presented) on participation rates across wealth groupings reveal that credit instruments are evenly allocated across groupings with 10 per cent of the poorest households holding formal credit instruments together with 10 per cent of the wealthiest households. By contrast, participation in formal savings and credit markets is dominated by wealthier households.

To measure social capital for households in our sample we follow an approach similar to Jowett (2003) and construct an index to represent the overall strength of social capital that a household possesses.[13] We first turn to Stone et al. (2002) to motivate our choice of social capital variables to include in the index measure with the aim of separating (where practicable) the component social capital proxies from measures of its outcomes and determinants. Focussing exclusively on the measurement of *informal* networks as presented by Stone et al. (2002), we first consider three proxy representations which are predicted (under certain conditions) to give rise to shared trust, norms and values at a community level. These are binary indicators of: 1) whether a household believes they *could* turn to social networks in times of distress; 2) whether a household *would* rely on reciprocity from this

[13] Jowett (2003) in his Vietnamese study of informal risk sharing networks and health insurance, constructed two proxy measures of social capital with the first assessing perceptions of social cohesion within the respondent's community based on a direct question to respondents and responded against a five-point scale and the second capturing the density of horizontal linkages in the local community.

social network; and 3) a decision variable indicating whether a household frequently turns to these informal social networks. We also consider three binary representations for social norms, trust and diversity: 1) whether a household believes most people in the local area are honest and trustworthy; 2) whether a household relies on help from someone from the same ethnicity; and 3) whether a household relies on help from someone from the same village. Summary statistics for these candidate indicator measures of social capital are presented in Table 1.4.

Table 1.4: Proxies for Social Capital

	Percentage of Households
Informal Networks Measure	
Whether household could turn to informal social networks for help	95%
Whether household would rely on reciprocity	25%
Whether household often turns to informal social networks for help	75%
Shared Trust, Norms, Diversity	
Whether household relies on someone else from the village	76%
Whether household relies on someone from the same ethnicity	92%
Whether household believes most people to be honest and trustworthy	83%

The data reveal that social capital in the form of informal networks is a dominant feature of rural life in Vietnam with 95 per cent of households reporting they felt they *could* turn to informal networks in situations of emergency. Moreover, 75 per cent of households report frequent contact with members of their informal network. The concept of reciprocity is weaker in that only 25 per cent of households report that informal help and advice goes both ways. Turning to proxy measures of shared norms, trust and values, the data reveal that 83 per cent of households *believe* most people in their village to be honest and trustworthy. The fact that 92 per cent of households rely on someone of the same ethnicity for help while 76 per cent of households rely on someone from the same village for help provides some (although subjective) evidence of the strength of common trust and shared norms in rural Vietnamese contexts. Finally, we construct an overall index of the strength of social capital

which combines *all* proxy elements of informal networks and social norms identified and presented in Table 1.4 and allows for the fact that up to three people in the household may be selected as the principal members of a household informal network.[14] Overall index values range from 0 to a maximum value of 9. We find that on average the strength of social capital is 4.37 with a standard deviation of 2.33.

1.4 Estimation Strategy

1.4.1 Empirical Model and Estimation

In our estimation of the determinants of household demand for formal financial services we consider that the three decisions, 1) demand for formal savings, 2) demand for formal credit, and 3) demand for formal insurance, are made simultaneously. These three decision dependent variables are represented as binary variables indicating whether or not a household has participated in formal savings markets, formal credit markets and/or formal insurance markets within the time period 2008 to 2010.

We classify households with formal savings (coding '1') as those holding an amount of money: 1) in postal savings; 2) with state owned commercial banks; 3) with private banks; or 4) with a credit or any other private organization. Hence, we do not differentiate between those households who report to save formally for productive capital accumulation or other purposes. We classify households holding formal insurance (coding '1') as those having purchased voluntary contracts from any public, domestic private or foreign provider.[15] Households holding formal credit are classified as those with a loan amount (coding '1') outstanding in 2010 with any of the following institutions: 1) the VBSP; 2) the VBARD; 3) other state owned commercial banks; 4) local authorities; or 5) private banks.

We represent the simultaneous choices facing a household by three latent variables, S^*, B^*, I^*: where S^* represents the utility difference between saving formally and not, B^* represents the utility difference between holding formal credit or not and I^* represents the difference between holding voluntary formal insurance or not. We assume that these three latent

[14] Average household size is 4.2 members for those households reporting an informal network of 3, 2 and 0 members. Households reporting an informal network of 1 member have an average size of 4.4 members. Due to these similarities in average household size together with the upper bound data constraint of a maximum of 3 members to a household's informal network, we do not explicitly adjust the social capital index variable for household size. Household size is used as a separate control variable within the main demand estimations.

[15] The raw data reveal that 97 per cent of formal voluntary insurance contracts are held with public institutions.

decision variables are explained by the same set of characteristics as the observed actions of the household. Hence, we refer to Cappellari and Jenkins (2003) and consider a three-equation multivariate probit model where:

$$S_i^* = \boldsymbol{\beta}_S' \boldsymbol{X}_{iS} + \epsilon_{iS}$$
$$B_i^* = \boldsymbol{\beta}_B' \boldsymbol{X}_{iB} + \epsilon_{iB}$$
$$I_i^* = \boldsymbol{\beta}_I' \boldsymbol{X}_{iI} + \epsilon_{iI} \quad (1)$$

and where $\boldsymbol{X_i}$ represents a vector of explanatory variables common across all three decision equations, $\boldsymbol{\beta_S}, \boldsymbol{\beta_B}, \boldsymbol{\beta_I}$ represent three unknown vectors of parameters and where:

$$S_i = 1 \text{ if } S_i^* > 0 \text{ and 0 otherwise}$$
$$B_i = 1 \text{ if } B_i^* > 0 \text{ and 0 otherwise}$$
$$I_i = 1 \text{ if } I_i^* > 0 \text{ and 0 otherwise} \quad (2)$$

with S_i, B_i, I_i representing the binary outcomes for the three financial decisions taken at the same point in time. The error terms $\epsilon_{iS}, \epsilon_{iB}, \epsilon_{iI}$ from equation (1) are distributed as multivariate normal with a mean of 0 and a variance-covariance matrix Σ which is represented as:

$$\Sigma = \begin{pmatrix} 1 & \rho_{SB} & \rho_{SI} \\ \rho_{BS} & 1 & \rho_{BI} \\ \rho_{IS} & \rho_{IB} & 1 \end{pmatrix} \quad (3)$$

with $\rho_{SB}, \rho_{SI}, \rho_{BI}$, representing the off-diagonal correlation coefficients. Hence the log-likelihood function for a sample of N independent cross-sectional household observations is given by (see Cappellari and Jenkins (2003) pages 279-280 for full details):

$$\mathcal{L} = \sum_{i=1}^{N} log\Phi_3(\mu_i; \Omega) \quad (4)$$

where $\Phi_3(.)$ is the trivariate standard normal distribution with arguments μ_i and Ω and where:

$$\mu_i = (K_{iS}\boldsymbol{\beta}_S'\boldsymbol{X}_{iS}, K_{iB}\boldsymbol{\beta}_B'\boldsymbol{X}_{iB}, K_{iI}\boldsymbol{\beta}_I'\boldsymbol{X}_{iI}) \quad (5)$$

with $K_{iS} = 2S_i - 1$, $K_{iB} = 2B_i - 1$ and $K_{iI} = 2I_i - 1$. These terms will equal one if a household participates in that particular financial service market and minus one otherwise (see Greene 2003, page 710).

The matrix Ω from equation (4) is thus represented as:

$$\Omega = \begin{pmatrix} 1 & K_{iS}K_{iB}\rho_{SB} & K_{iS}K_{iI}\rho_{SI} \\ K_{iB}K_{iS}\rho_{BS} & 1 & K_{iB}K_{iI}\,\rho_{BI} \\ K_{iI}K_{iS}\rho_{IS} & K_{iI}K_{iB}\rho_{IB} & 1 \end{pmatrix} \quad (6)$$

According to Cappellari and Jenkins (2003), the most common method for estimation of equation (4) is the Geweke-Hajivassiliou-Keane (GHK) smooth recursive simulator which exploits the properties that a trivariate normal distribution function can be expressed as the product of three sequentially conditioned univariate normal distribution functions. In order to evaluate the resulting integral, a number of random draws of these standard normal variables are taken from truncated normal distributions, and a sample average of the simulated probabilities is used to estimate the probability that enters the likelihood function. Hence under the assumption that the composite error term $\epsilon \sim N(0, \Sigma)$, the correlation coefficients ρ_{SB}, ρ_{SI}, $\rho_{BI,}$ represent the relationship between the unobservable household specific factors which determine the likelihood of simultaneous participation in formal savings, formal credit and formal insurance markets.[16] Note that if the error terms $\epsilon_{iS}, \epsilon_{iB}, \epsilon_{iI}$ from equation (1) are independent of one another then each probit model can be estimated separately and equation (4) reduces to three separate standard normal distributions with $\rho_{SB} = \rho_{SI} = \rho_{BI} = 0$. Under our specific assumptions that $\rho_{SB} \neq 0, \rho_{SI} \neq 0, \rho_{BI} \neq 0$ then the error terms from equation (1) are correlated and the probability of one dependent variable will be dependent on the probability of the other two. Hence their joint cumulative distribution function in equation (4) includes correlation parameters, $\rho_{SB}, \rho_{SI}, \rho_{BI}$. Failure to account for such correlations may result in upward/downward bias of estimated coefficients depending upon the sign and magnitude of each ρ.

[16] Estimations are implemented with Stata, using the **mvprobit**, routine developed by Cappellari and Jenkins (2003, 2006).

We estimate the average partial effects (APEs) of the marginal probabilities of each explanatory variable in vector $\boldsymbol{X}_i$ in each equation by averaging sample partial effects, calculated for each household. In order to compute the APEs on the joint probabilities of using combinations of formal financial services, we adopt an underlying stata routine first developed by Kis-Katos (2007) (and also incorporated by Bendig et al. (2009)) together with the supporting stata code developed by Bendig et al. (2009).[17] This routine also estimates the standard errors of each APE using an empirical Bayes procedure. Within this procedure a number of replications of the vector of estimated coefficients $(\widehat{\boldsymbol{\beta}}_{\boldsymbol{S}}, \widehat{\boldsymbol{\beta}}_{\boldsymbol{B}}, \widehat{\boldsymbol{\beta}}_{\boldsymbol{I}}, \hat{\rho}_{SB}, \hat{\rho}_{BI}, \hat{\rho}_{IS})$ are redrawn from a multivariate asymptotically normal distribution (characterized directly by the estimated variance covariance matrix $\hat{\Sigma}$) and the standard deviation of the each partial effect is calculated as an approximation of the standard error of the partial effects.

1.4.2 Endogeneity of Social Capital

We include our overall index measure of social capital as part of the vector of explanatory variables $\boldsymbol{X}_i$ detailed in equation (1). The direct inclusion of this composite measure of informal network participation and representations of social norms and trust into the trivariate probit model could potentially introduce endogeneity to the model yielding biased and inconsistent estimates. It could be argued, for example, that the extent to which households rely on informal networks and place trust in others will depend upon unobserved household characteristics such as risk aversion which will be included in the composite error term of the formal financial services demand model ($\epsilon_{iS}, \epsilon_{iB}, \epsilon_{iI}$ in equation (1)).

Hence, in constructing our index measure for social capital we attempt to control for the time variant component of this endogenous variable by using lagged social capital component variables which do not (where possible) represent prior decision variables. Hence our component measures of informal networks derive from the *prior* subjective aspirations of the household as opposed to actual decisions taken. For example, the third proxy for informal networks (see Table 1.4) is based on a prior decision variable and is represented by the number of members of the local village network the household frequently turned to. Further, we represent the trust index component with a lagged measure of whether a household

[17] The stata code used to calculate the average partial effects (APEs) for the marginal probabilities was kindly provided by Mirko Bendig and makes direct use of the **mvpred** routine within Stata developed by Cappellari and Jenkins (2003, 2006). Mirko Bendig also provided the routines to generate the APEs of the joint probabilities (which also directly uses the code developed by Krisztina Kis-Katos) and makes use of the computationally intensive empirical Bayes procedure to approximate the standard errors.

believed most people to be honest and trustworthy in the past. Although our index component measures for social capital norms represent lagged decision variables which represent 1) whether the household relied on someone for help from the same village or 2) the number of people of the same ethnicity that the household relied on for help, we argue that these are plausibly more exogenous representations than current period decision variables. It must be emphasised however that due to the cross-sectional nature of our data, we cannot control for household fixed effects/time invariant heterogeneity.[18] Finally, the construction of our index of the overall strength of social capital per household incorporates all lagged components measures from 2006 through 2008.

In our initial consideration of the singular underlying components of social capital we align with Durlauf and Fafchamps (2004) exposition by first seeking evidence that trust and shared norms are achieved *via* social interaction based on interpersonal networks and associations. The existence of this relationship is essential in order for social networks and associations to be part of the definition of social capital. To test these relationships we conduct preliminary estimations in order to understand the effect of informal network participation on shared trust and norms. We conduct simple regressions of our lagged proxy measures for shared values and trust on measures of informal network participation. Results indicate that in all cases informal networks are positively correlated with shared norms.[19] These results may suffer from simultaneity bias however albeit in the case that shared norms and values existed *prior* to seeking help informally from neighbours and friends. It must therefore be emphasised that we cannot explicitly disentangle whether informal networks and organizations directly give rise to shared norms, trust and values or vice versa.

1.4.3 Hypothesis Testing

Aside from the principal hypothesis regarding the positive effect of social capital on formal financial services demand our empirical model from equation (1) also allows us to test a number of other interesting predictions. Much of the empirical literature investigating insurance demand finds that household characteristics should be included as important controls for heterogeneity in the degree of risk aversion across households (Magrabi et al., 1991). Showers and Shotick (1994) hypothesise that the specific characteristics related to household demand for insurance include family size, age, number employed and income.

[18] District level fixed effects are included.
[19] These results are presented in Table 1.1.1 of Appendix 1.1 which accompanies this chapter.

They also consider how the number of household earners interacts with income to influence insurance demand. They propose that multi-earner households perceive less risk of loss of income than single-income households, even at the same income level. In contrast, families with many members may in fact be more risk averse as they are more exposed to shocks. Lazear and Micheal (1988) suggest that there may also be economies of scale in insurance purchase and so as a family size increases we would expect demand for insurance to also increase, but at a decreasing rate. We use the number of household members to control for scale economies and the age of the head of household as a proxy for the overall lifecycle stage of a family unit. As families age, the level of income and number of dependents tend to rise. This should result in an increase in risk aversion and so an increase in household demand for insurance.[20] However, in the declining years of a family, we would expect the demand for insurance to decrease as the family reaches the end of their lifecycle with less insurable risk. This relationship may be curvilinear (Duker, 1969), a consideration also made in our model.

In relation to the demand for formal credit, Pitt and Khandker (2002) find evidence that gender and education level of the household head are significant predictors of demand. We therefore include both of these characteristics in the model to test whether this is also the case in our data.

When focussing on household demand for formal savings we specifically investigate whether the determinants of savings demand in rural Vietnam contradict the theoretical assumptions of the lifecycle theory (Ando and Modigliani, 1963; Deaton, 1992; Spio and Groenwald, 1996) or the permanent income hypothesis (Friedman, 1957). Hence, we include remittances in the form of private transfers to investigate whether strong family ties make it less necessary to save for future retirement.[21] Kiiza and Pederson (2002) show that the decision to hold a bank savings deposit in Uganda is positively related to the proximity to the financial institution among other factors. We therefore include distance variables representing the

[20] We acknowledge that wealth (and income) is a poor proxy for risk aversion and the associated demand hypotheses are identifiable only if CARA household preferences are imposed. Furthermore, data quality constraints prevented the use of survey data relating to specific questions seeking to judge risk aversion.

[21] The trivariate probit model does not constrain the parameter vectors in all equations to be equal as would be the case in a panel univariate probit model. As such, we conduct estimations in a cross-sectional capacity. Notwithstanding, we do incorporate empirical lifecycle hypothesis testing as some insights can be gained regarding how propensities for formal savings/credit/insurance participation differ with age at a given point in time.

distance of the household to the nearest commune and to the nearest all-weather road to capture remoteness from a financial institution.

Finally, in order to capture the impact of income risk and income shocks on household demand for formal financial services we also include proxy measures representing categories of income risk together with indicators of current period income shocks in our analysis. Zeller and Sharma (2002) argue that obtaining credit during periods of financial stress as a consequence of adverse income shocks features strongly in the livelihoods of the rural poor. Further, precautionary savings are relevant if the marginal utility of income is both decreasing and convex and hence we would expect to see an increase in formal savings brought about by an increase in income risk (Beasley, 1995). It is also interesting to capture whether households purchase formal insurance in the presence of income risk (Arrow, 1963).[22] We also capture a measure for persistence by including an indicator of whether a household has fully recovered from prior income shocks.[23]

1.5 Empirical Results

We first attempt to empirically validate the trivariate probit estimation methodology by estimating a model excluding social capital variables. Noteworthy is that the estimated correlation coefficients between the unobserved savings and credit decision is $\rho_{SB} = -0.19$, between the savings and insurance decision is $\rho_{SI} = 0.15$ and between the credit and insurance decision is $\rho_{BI} = 0.13$. The positive and significant signs between 1) savings and insurance and 2) credit and insurance suggest that insurance serves as a complementary strategy for both savings and credit instruments. By contrast, savings and credit are negatively (and significantly) correlated which is suggestive of substitutability. Hence, our hypothesis that the same unobservable factors simultaneously influence formal savings, credit and insurance decisions is supported by an overall χ^2 statistic of 18.15 against the null of $\rho_{SB} = \rho_{SI} = \rho_{BI} = 0$.[24]

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[22] We acknowledge that the formal insurance we observe is partial and unlikely to be actuarially fair. Moreover, we acknowledge that risk aversion may not be sufficient to characterise the demand for partial (formal) insurance within a developing country context. See Besley (1995) p. 2158 for a detailed discussion on how partial insurance on some income component may not be sufficient to lower overall income risk.

[23] This analysis draws upon the income risk and income shock variables constructed by Wainwright and Newman (2011) and the income risk variables augmented by Wainwright et al. (2012).

[24] Estimations of three separate univariate probit models indicate that coefficients on savings demand suffer downward bias while coefficients on credit and insurance demand suffer from upward bias relative to the trivariate probit estimates. The estimation results of the univariate probit models are presented in Table 1.1.2 of

1.5.1 Social Capital

We first apply our composite measure representing a lagged proxy for the overall strength of social capital included separately in vector $\boldsymbol{X_i}$ for each separate demand equation defined by equation (1). Table 1.5 presents the trivariate probit results for each separate equation and includes both the estimated coefficients and the average partial effects (APEs). It is important to note as per Bendig et al. (2009) that the categories of dependent variables are not mutually exclusive. Put differently, households who demand formal insurance for example, can also demand 1) either formal credit or savings; 2) both credit and savings or 3) or neither. Furthermore, although our estimation includes district level controls with robust standard errors clustered at the district level, the cross-sectional nature of our model means that we cannot completely exclude forms of endogeneity within and across each participation equation. Hence, all estimation results should be treated with caution and are at best indicative of correlations.

Results suggest that social capital increases the likelihood of participation in formal credit markets and formal insurance markets as evidenced by the positive average partial effect (APE) in each case. More difficult to empirically identify in this case is the underlying mechanism which precisely gives rise to these positive participation effects. Here, as outlined in Section 1.2, we echo Newman at al (2012) when they discuss how social norms may lead group members to behave in a similar way and speculate that our composite social capital proxy is also capturing an information effect – although we cannot state this conclusively. In order to test for the robustness of these initial findings, we now explore joint and pair-wise probabilities respectively.

Appendix 1.1 which accompanies this chapter. It must be acknowledged that although the trivariate probit model does place restrictions on the data, it emerges as the most appropriate estimation model due to the significance of the estimated correlation coefficients $\rho_{SB}, \rho_{SI}, \rho_{BI}$.

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Table 1.5: Multivariate probit results on the Demand for Formal Financial Services

Independent Variables	***Dependent Variable: Demand for Formal Savings S_i***			***Dependent Variable: Demand for Formal Credit B_i***			***Dependent Variable: Demand for Formal Insurance I_i***		
	Coeff	**APEs**	**t-stat**	**Coeff**	**APEs**	**t-stat**	**Coeff**	**APEs**	**t-stat**
Social Capital Index	0.0334	0.0028	0.96	0.0417	0.0123	2.14**	0.0345	0.0087	2.15**
Natural Risk	0.0399	0.0034	0.26	0.0453	0.0139	0.49	0.0322	0.0081	0.28
Economic Risk	-0.1781	-0.0147	-0.95	0.2223	0.0697	1.41	0.4380	0.1061	2.59**
Idio – Insurable Risk	0.2204	0.0182	1.09	0.0711	0.0228	0.56	0.1170	0.0265	0.90
Idio – Uninsurable Risk	0.3658	0.0360	1.18	0.2033	0.0657	1.29	0.2856	0.0606	1.40
Not Recovered – Prior Shocks	-0.4253	-0.0442	-2.20**	-0.0169	-0.0055	-0.17	-0.2208	-0.0451	-2.00**
Natural Shocks	-0.0760	-0.0069	-0.48	0.0842	0.0273	1.01	0.1681	0.0358	1.49
Economic Shocks	-0.3946	-0.0308	-1.08	0.0773	0.0249	0.27	-0.1685	-0.0358	-0.51
Idio-Insurable Shocks	0.2032	0.0145	0.99	-0.1831	-0.0592	-1.45	0.1002	0.0216	0.66
Idio-Uninsurable Shocks	-0.5330	-0.0339	-1.32	0.1405	0.0456	0.94	-0.1315	-0.0285	-0.55
Not Recovered – Current Shocks	-0.1140	-0.0054	-0.46	-0.0242	-0.0078	-0.23	-0.1003	-0.0225	-0.92
Private Transfers	0.2445	0.0107	1.77*	-0.1044	-0.0337	-1.09	-0.0893	-0.0203	-0.84
Public Transfers	0.0200	0.0010	0.13	0.1563	0.0506	1.86*	-0.3857	-0.0911	-4.16***
Wage Income (Log)	-0.0098	-0.0008	-0.73	0.0036	0.0011	0.42	0.0013	0.0003	0.14
SME Indicator	-0.0388	-0.0019	-0.25	0.0493	0.0038	0.60	0.1281	0.0047	1.50
Total Area Farmed (Lag)	-0.0007	-0.0001	-0.13	0.0028	0.0008	0.86	0.0028	0.0007	0.79
Wealth Group (Lag)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HH Size	0.0030	0.0003	0.05	-0.0080	-0.0024	-0.27	0.0384	0.0097	1.37
Age	0.0418	0.0037	2.08**	0.0367	0.0110	2.81***	0.0651	0.0164	4.27***
Age Squared	-0.0003	-0.0000	-1.18	-0.0007	-0.0002	-0.83***	-0.0008	-0.0002	-4.63***
Gender (1 Male, 0 Female)	-0.1684	-0.0087	-1.08	0.2074	0.0673	2.07**	0.0341	0.0084	0.31
Education	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Distance – Road	-0.0143	-0.0013	-0.40	0.0124	0.0037	1.31	-0.0098	-0.0025	-0.63
Distance – Commune	-0.0338	-0.0029	-0.63	0.0316	0.0095	1.35	0.0145	0.0037	0.45
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes for Table 1.5: Results of the trivariate probit model are estimated by Simulated Maximum Likelihood with 20 pseudorandom draws. All reported t-statistics refer to the original estimated coefficients and are based on robust standard errors clustered at the district level. Average partial effects (APEs) are generated from the marginal probability of using each type of formal financial service. The model also includes a constant. Sample size is N=2030 observations. *** indicates significance at 1 per cent, ** indicates significance at 5 per cent, * indicates significance at 10 per cent. Source: The main stata routine to generate the APEs was kindly provided by Mirko Bendig.

We first present the APEs on the joint trivariate probability of any given combination of financial services. Further, by exploring the determinants of household demand for different pair-wise combinations of formal financial services we can better understand which markets are impacted by social capital to the exclusion of others. Hence, the exploration of participation combinations in this fashion may also facilitate a deeper insight into the probable underlying mechanisms behind any outcomes associated with social capital. These estimation results are split for ease of illustration across Tables 1.6 and 1.7. Table 1.6 details the APEs on the joint trivariate probability of using: 1) no formal financial service whereby $S_i = 0, B_i = 0, I_i = 0$ (see equation (2)); 2) all three financial services whereby $S_i = 1, B_i = 1, I_i = 1$; and 3) formal savings only whereby $S_i = 1, B_i = 0, I_i = 0$. Table 1.7 focuses on pair-wise combinations of formal financial services by detailing the APEs on the joint trivariate probability of using: 1) savings and credit only whereby $S_i = 1, B_i = 1, I_i = 0$; 2) savings and insurance only whereby $S_i = 1, B_i = 0, I_i = 1$; and 3) credit and insurance only whereby $S_i = 0, B_i = 1, I_i = 1$.

Results confirm that social capital is important for household participation in all three markets for formal financial services as evidenced by the positive and significant APE in Table 1.6. A natural corollary to this result is the negative APE indicating that social capital *decreases* the likelihood of *no* participation in formal markets (also Table 1.6). These positive results provide some support for Guizo et al. (2000) whereby trust towards others, which forms an integral component of our social capital index, leads naturally to move transactions from the informal towards the formal (financial) market. Further, this evidence strengthens our speculation, as per Hoang Dinh Quoc et al. (2012), that the underlying mechanism by which this strong social capital is associated with positive financial services participation is through the transmission of information. Village households are more likely to act on information received from family and friends as they are perceived to be more trustworthy (Haythornthwaite, 1996). Moreover, strong social ties may also provide helpful information even when this information has not been actively searched for (Lai and Wong,

2002). This may be particularly true in the case of formal insurance markets where the transaction costs of participation are particularly high.

Exploring now our specific pair-wise combinations as a further robustness check confirms the positive association already evidenced between social capital and both credit and insurance market participation but now with the exclusion of savings (Table 1.7). This result associated with *informal* social networks and increased participation in formal credit and insurance markets compliments that of Newman et al. (2012) who instead find a similar result for formal savings whereby membership of high 'quality' Women's Unions (or *formal* social groups) leads to higher levels of formal savings.

Table 1.6: Average Partial Effects on Joint Probabilities of Using 1) No Formal Financial Services and 2) All Three Formal Financial Services and 3) Savings Only

Independent Variables	***Dependent Variable: No Formal Savings, No Credit, No Insurance*** $(!S_i \text{ and } !B_i \text{ and } !I_i)$		***Dependent Variable: Formal Savings, Credit, Insurance*** $(S_i \text{ and } B_i \text{ and } I_i)$		***Dependent Variable: Formal Savings Only*** $(S_i \text{ and } !B_i \text{ and } !I_i)$	
	APEs	**t-stat**	**APEs**	**t-stat**	**APEs**	**t-stat**
Social Capital Index	-0.0128	-3.39***	0.0013	2.25**	-0.0003	-0.34
Natural Risk	-0.0161	-0.27	0.0008	0.23	-0.0007	-0.16
Economic Risk	-0.0206	-0.48	-0.0052	-1.42	-0.0115	-2.22**
Idio – Insurable Risk	-0.0300	-1.16	0.0061	1.49	0.0052	0.72
Idio – Uninsurable Risk	-0.0170	-0.40	0.0037	0.47	0.0006	0.07
Not Recovered – Prior Shocks	0.0344	1.36	-0.0072	-2.25**	-0.0078	-1.60
Natural Shocks	-0.0415	-1.65*	0.0029	0.83	-0.0036	-0.85
Economic Shocks	0.0592	0.82	-0.0023	-0.32	0.0061	0.44
Idio-Insurable Shocks	-0.0199	-0.66	0.0042	0.96	0.0058	0.96
Idio-Uninsurable Shocks	0.0004	0.01	-0.0040	-0.74	-0.0082	-1.04
Not Recovered – Current Shocks	0.0237	0.90	-0.0033	-0.89	-0.0021	-0.36
Private Transfers	0.0021	-0.08	0.0041	1.50	0.0076	1.83*
Public Transfers	0.0468	2.78**	-0.0006	-0.24	0.0053	1.17
Wage Income (Log)	-0.0009	0.41	-0.0001	-0.50	-0.0002	-0.39
SME Indicator	-0.0429	-2.13**	-0.0025	0.84	-0.0138	-0.90
Total Area Farmed (Lag)	-0.0009	-1.12	0.0001	1.08	-0.0001	-0.46
Wealth Group (Lag)	Yes	Yes	Yes	Yes	Yes	Yes
HH Size	-0.0024	-0.40	-0.0002	0.20	-0.0005	-0.27
Age	-0.0183	-5.78	0.0018	3.70***	-0.0003	-0.54
Age Squared	0.0002	6.49***	-0.0000	-3.74***	0.0000	2.29**
Gender (1 Male, 0 Female)	-0.0151	-0.76	-0.0032	-1.04	-0.0136	-2.17**
Education	Yes	Yes	Yes	Yes	Yes	Yes
Distance – Road	-0.0016	-0.72	-0.0000	-0.05	-0.0005	-0.81
Distance – Commune	-0.0005	-0.08	-0.0011	-1.20	-0.0024	-1.64
Province Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

Notes for Table 1.6: Average partial effects (APEs) are generated from the joint trivariate probability of each outcome (directly from the trivariate probit model). Sample size is N=2030 observations. T-statistics are approximated by parametric bootstrapping. *** indicates significance at 1 per cent, ** indicates significance at 5 per cent, * indicates significance at 10 per cent. Source: The main stata routines to generate the APEs was kindly provided by Mirko Bendig with permission from Krisztina Kis-Katos..

Table 1.7: Average Partial Effects on Joint Probabilities of Using 1) Savings and Credit 2) Savings and Insurance 3) Credit and Insurance

Independent Variables	***Dependent Variable: Formal Savings and Credit, No Insurance*** $(S_i \text{ and } B_i \text{ and } !I_i)$		***Dependent Variable: Formal Savings and Insurance, No Credit*** $(S_i \text{ and } !B_i \text{ and } I_i)$		***Dependent Variable: Formal Credit and Insurance, No Savings*** $(!S_i \text{ and } B_i \text{ and } I_i)$	
	APEs	**t-stat**	**APEs**	**t-stat**	**APEs**	**t-stat**
Social Capital Index	0.0002	0.78	0.0016	1.26	0.0075	2.67***
Natural Risk	0.0004	0.35	-0.0032	-0.47	0.0095	0.66
Economic Risk	-0.0025	-2.15**	-0.0125	-1.50	0.0204	0.69
Idio – Insurable Risk	0.0013	0.79	0.0140	1.39	0.0078	0.37
Idio – Uninsurable Risk	0.0013	0.50	0.0013	0.08	0.0128	0.50
Not Recovered – Prior Shocks	-0.0018	-1.52	-0.0172	-2.47**	-0.0075	-0.48
Natural Shocks	-0.0000	0.17	0.0003	0.03	0.0292	1.84*
Economic Shocks	0.0018	0.49	-0.0081	-0.50	-0.0288	-0.69
Idio-Insurable Shocks	0.0003	0.20	0.0197	1.64	-0.0093	-0.50
Idio-Uninsurable Shocks	-0.0010	-0.31	-0.0170	-1.62	0.0184	0.72
Not Recovered – Current Shocks	-0.0007	-0.41	-0.0076	-0.89	-0.0086	-0.49
Private Transfers	0.0015	1.54	0.0115	1.79*	-0.0086	-0.53
Public Transfers	0.0026	2.25**	-0.0125	-2.18**	-0.0118	-0.98
Wage Income (Log)	-0.0000	-0.03	-0.0006	-1.01	0.0001	0.09
SME Indicator	-0.0006	-0.70	0.0048	0.77	0.0231	1.58
Total Area Farmed (Lag)	0.0000	0.73	-0.0001	-0.38	0.0008	1.31
Wealth Group (Lag)	Yes	Yes	Yes	Yes	Yes	Yes
HH Size	-0.0003	-0.77	0.0013	0.63	-0.0008	-0.17
Age	0.0002	1.08	0.0026	2.52**	0.0103	4.99***
Age Squared	0.0000	-0.81	-0.0000	-1.42	-0.0002	-6.40***
Gender (1 Male, 0 Female)	-0.0011	-0.87	-0.0235	-2.68***	0.0351	2.49**
Education	Yes	Yes	Yes	Yes	Yes	Yes
Distance – Road	0.0000	0.02	-0.0009	-1.05	0.0023	1.42
Distance – Commune	-0.0004	-1.11	-0.0039	-1.85*	0.0043	1.00
Province Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

Notes for Table 1.7: Average partial effects (APEs) are generated from the joint trivariate probability of each outcome (directly from the trivariate probit model). Sample size is N=2030 observations. T-statistics are approximated by parametric bootstrapping. *** indicates significance at 1 per cent, ** indicates significance at 5 per cent, * indicates significance at 10 per cent. Source: The main stata routines to generate the APEs was kindly provided by Mirko Bendig with permission from Krisztina Kis-Katos..

1.5.2 Other Hypotheses

In order to test our other hypotheses we turn to Tables 1.5, 1.6 and 1.7. Focussing first on our measures capturing the effect of categories of income risk and income shocks on formal financial services demand results indicate that the persistence of prior income shocks is a significant determinant of demand. For example, Table 1.5 illustrates that households not fully recovered from prior income shocks are less likely to save formally and less likely to participate in formal insurance markets. Moreover, income shock persistence reduces the likelihood that a household will participate in all three financial services markets (Table 1.6) while the likelihood of participation in formal savings and insurance markets only is also reduced (Table 1.7). Taken together these results suggest that risk matters for formal financial services participation and that households struggling to recover from categories of income shocks de-prioritise formal savings – possibly because they are actually dis-saving as part of an overall risk-coping strategy (Wainwright and Newman 2011). Furthermore, there is no evidence that formal savings serve as a pre-emptive response to income risk with economic risk reducing the likelihood of a household engaging in formal savings only (Table 1.5). This aligns with the results of Bendig et al. (2009) and also supports Newman et al. (2012) who argue that formal savings are more likely to be used for productive investments in the future. The demand for formal credit *and* savings also reduces with economic risk (Table 1.7), while the demand for formal insurance *increases* with economic risk (Table 1.5) which suggests that insurance also serves a risk-coping purpose.[25]

Turning now from pre-emptive responses to income risk to reactive demand responses to current period income shocks and results suggest that natural shocks decrease the likelihood that a household participates in no market for formal financial services (Table 1.5). In support of this finding, results also indicate that participation in formal credit *and* insurance markets

[25] Economic risk refers to risk of crop price changes, input shortages (or changes in price), other price changes, unemployment, unsuccessful investment, loss of land or crime. As such it is difficult to speculate which type of formal insurance would mitigate the impact of these events. A more detailed study of insurance demand across all observed categories of insurance is required to shed light on this issue.

increases for households experiencing current period natural shocks. This result supports the finding of Wainwright and Newman (2011) who find that households increase total borrowing in response to natural shocks.[26] The findings of Zeller and Sharma (2002) also support this result. Overall, we find that only current period natural shocks have a significant impact on a household's participation in formal financial markets with increased formal credit participation most likely serving risk-coping purposes.

Focussing exclusively on our insurance demand hypotheses (see Table 1.5), we find evidence of a curvilinear (Duker, 1969) relationship whereby formal insurance demand increases with age but at a declining rate. This is evidenced by the positive APE against the age of head of household together with the negative APE against the age squared variable. Controlling for components of risk aversion using household wealth as a proxy we find that the likelihood of insurance participation increases in wealth suggesting that formal insurance is a normal good. We find that household size is not a significant predictor of insurance participation thus rejecting Lazear and Micheal's (1988) hypothesis regarding economies of scale in insurance purchase. The level of education of the head of household has a positive and significant effect on the likelihood of a household demanding formal insurance. This could be due to the fact that educated households are more aware of risks or else simply that they have more information about formal insurance products. An insignificant relationship between the indicator of enterprise activity and formal insurance participation is also found suggesting that enterprise activity may serve as a form of income smoothing thus reducing the requirement for a household to formally insure. Results also indicate that households in receipt of public transfers are less likely to participate in formal insurance markets thereby indicating that forms of government support such as Veterans' pensions may in fact be 'crowding out' the private insurance market. It should be noted that households in receipt of public transfers are more likely *not* to participate in *any* market for formal financial services (Table 1.6) which lends support to the crowding out hypothesis.

Exploring the determinants of household credit (Table 1.7) and in contrast to the evidence provided by Pitt and Khandker (2002), we find no evidence that gender and education level of the household head are significant predictors of demand. Although we do find lifecycle effects, we find no evidence that the education level of the household head predicts

[26] Wainwright and Newman's (2011) result refers to total household borrowing (both formal and informal) over time.

household formal credit participation. This suggests that the transaction costs (in terms of knowledge acquisition) may be lower for formal credit than for formal insurance instruments. We also find that households in receipt of public transfers are more likely to demand formal credit which suggests that such transfers may serve as useful collateral for formal loans.

Focussing now on household demand for formal savings (Table 1.5) we specifically investigate whether the determinants of savings demand in rural Vietnam contradict the theoretical assumptions of the life - cycle theory (Ando and Modigliani, 1963) or the permanent income hypothesis (Friedman, 1957). We find that remittances in the form of private transfers make it more likely to participate in private savings markets. We also find that the likelihood of saving increases with age but at a declining rate (although the negative coefficient against age squared is not statistically significant). Hence, these results provide broad support for the lifecycle hypothesis of saving at adulthood but dis-saving when retired.[27]

Finally, we explore the significant determinants of household participation in pair-wise combinations of formal financial services markets (Table 1.7). As discussed previously, this offers deeper insight into the demand determinants for some financial services with the exclusion of others. Results suggest that households in receipt of private transfers are more likely to participate in savings *and* insurance markets only. By contrast receiving public transfers makes this less likely while increasing the likelihood of formal savings *and* credit participation only. An interesting finding relates to APE for the gender of the head of household whereby males are less likely to participate in savings *and* insurance markets only and are more likely to participate in formal credit *and* insurance markets only (relative to female heads of households). This is suggestive that formal credit may be accessed more by males than females although we cannot state this conclusively.

1.6. Conclusions

This paper applies a simultaneous estimation methodology using a trivariate probit model to evaluate likely barriers to rural Vietnamese household participation in formal financial services including savings, credit and insurance markets. We identify observable variables

[27] We are interpreting the lifecycle hypothesis of Franco Modigliani (LCH) as an attempt to look more realistically at what determines the level of savings in an economy than the permanent income hypothesis of Milton Friedman (PIH).

which we argue are plausible proxies for rural village level social capital and incorporate these in an index construction into a household demand analysis in order to shed light on whether informal group membership is associated with positive externalities via shared trust and norms which translate into increased demand for formal financial services. Other relevant demand hypotheses are similarly considered.

The jointly estimated participation equations for formal savings, credit and insurance allow us to control for unobservable household factors common to all three financial decisions. Moreover, the generation of pair-wise average partial effects offers deeper insight into the demand determinants for some financial services with the exclusion of others.

Our primary results suggest that social capital, proxied by village level informal networks and shared norms and trust is associated with increased household demand for formal credit and insurance. Hence, we speculate that informal networks facilitate an information transfer which results in positive demand outcomes. Newman et al. (2012) find a similar result for formal savings whereby membership of high 'quality' Women's Unions leads to higher levels of formal savings and higher levels of savings for productive purposes. More difficult to identify from our observational data is the underlying mechanism which precisely gives rise to these positive participation effects.

Other results indicate that a household's inability to fully recover from prior income shocks is negatively correlated with formal savings and formal insurance participation which together may have adverse implications for future household risk-coping capabilities. Moreover, the demand for credit and insurance increases with natural shocks which suggests that formal credit may be in part used for consumption smoothing purposes.

Overall, we conclude that informal networks are associated with social capital and positive financial services demand outcomes. Further, we hypothesise that these positive credit and insurance demand externalities are likely to arise via local information channels to the extent that free-flowing information is a by-product of personalized trust, which is in turn hypothesized to arise from repeated informal interactions. However, further analysis is required to state this conclusively.

Appendix 1.1: Tables

Appendix Table 1.1.1 Correlations between Informal Networks and Trust/Social Norms

Shared Trust, Norms, Diversity	Informal Networks Measure		
	Reliance on help	**Reliance on reciprocity**	**Frequency of help**
Same Village	0.0153***	0.045	0.044
	(0.053)	(0.031)	(0.033)
Same Ethnicity	0.950***	0.142***	0.276***
	(0.015)	(0.023)	(0.034)
Believes others trustworthy	0.780***	0.146***	0.604***
	(0.033)	(0.028)	(0.033)

Social capital correlations of nine separate regressions presented.
Robust standard errors clustered at the district level are given in parenthesis. District fixed effects included.
*** indicates significance at the 1% level, ** indicates significance at the 5% level, * indicates significance at the 10% level.

Appendix Table 1.1.2 Univariate Probit Demand Estimations

Independent Variables	***Dependent Variable Formal Savings S_i***	***Dependent Variable Formal Credit B_i***	***Dependent Variable Formal Insurance I_i***
Social Capital Index	0.034	0.042**	0.035*
	(0.030)	(0.018)	(0.018)
Natural Risk	0.031	0.046	0.037
	(0.150)	(0.084)	(0.093)
Economic Risk	-0.175	0.217	0.449**
	(0.316)	(0.161)	(0.180)
Idio – Insurable Risk	0.226	0.071	0.114
	(0.226)	(0.123)	(0.131)
Idio – Uninsurable Risk	0.305	0.206	0.274*
	(0.279)	(0.152)	(0.164)
Not Recovered – Prior Shocks	-0.413**	-0.022	-0.230**
	(0.185)	(0.093)	(0.107)
Natural Shocks	-0.098	0.080	0.171*
	(0.151)	(0.084)	(0.089)
Economic Shocks	-0.445	0.079	-0.175
	(0.369)	(0.214)	(0.229)
Idio – Insurable Shocks	0.216	-0.191	0.102
	(0.213)	(0.125)	(0.127)
Idio – Uninsurable Shocks	-0.583*	0.136	-0.143
	(0.347)	(0.156)	(0.166)
Not Recovered – Current Shocks	-0.127	-0.029	-0.097
	(0.201)	(0.096)	(0.105)
Private Transfers	0.217	-0.100	-0.085
	(0.154)	(0.083)	(0.087)
Public Transfers	0.013	0.158**	-0.384***
	(0.146)	(0.077)	(0.081)
Wage Income (Log)	-0.009	0.003	0.001
	(0.014)	(0.008)	(0.009)
SME Indicator	-0.068	0.042	0.121
	(0.141)	(0.079)	(0.085)
Total Area Farmed (Lag)	-0.001	0.002	0.003
	(0.006)	(0.003)	(0.003)
Wealth Group (Lag)	Yes	Yes	Yes
HH Size	0.005	-0.008	0.036
	(0.052)	(0.025)	(0.028)
Age	0.043*	0.038**	0.064***
	(0.024)	(0.015)	(0.015)
Age Squared	-0.000	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)
Gender (1 Male, 0 Female)	-0.195	0.200**	0.041
	(0.165)	(0.094)	(0.095)
Education	Yes	Yes	Yes
Distance – Road	-0.014	0.012	-0.009
	(0.021)	(0.008)	(0.010)
Distance – Commune	-0.039	0.033**	0.013
	(0.051)	(0.017)	(0.021)
District Fixed Effects	Yes	Yes	Yes
Constant	-3.470***	-1.712**	-1.913***
	(1.052)	(0.749)	(0.694)
Observations	1349	1999	1867

Standard errors are given in parenthesis. District fixed effects included.
*** indicates significance at the 1% level, ** indicates significance at the 5% level, * indicates significance at the 10% level.

Chapter 2:

Income Shocks and Household Risk-Coping Strategies: Evidence from rural Vietnam

2.0 Abstract

This paper considers the principal risk-coping strategies employed by rural households to mitigate consumption shortfalls caused by adverse idiosyncratic and covariant income shocks. Using household survey data from Vietnam we test the extent to which households smooth consumption intra-temporally in the face of categories of adverse income shocks, and explore how this depends on self-insurance instruments in the form of savings in various liquid assets and formal insurance contracts over time. We find that consumption is insulated from adverse income shocks for some, but not all, households. In order to protect consumption, households deplete liquid assets, in particular financial savings, and accumulate credit. Public insurance and external transfers assist in preserving cash holdings over time for some households. We conclude that formal insurance, and other government social safety nets, have the potential to assist households in coping with income losses. This would reduce the need for distress asset selling and for precautionary saving which would enable valuable household resources to be allocated more productively.

2.1 Introduction

A fundamental challenge facing rural households in developing countries is maintaining satisfactory levels of consumption when exposed to negative income shocks. Such shocks may adversely affect household welfare by impacting negatively on the income, wealth, and health of household members. This paper examines the negative consequences of adverse income shocks for household consumption across states of nature and for household savings over time. We categorize shocks as either idiosyncratic (for example injury, illness, etc.), that only affect an individual household, or spatially covariant (for example floods, drought), that affect all households in a particular geographic location. We postulate that risk averse households have high levels of precautionary saving because little risk, especially in developing country contexts, is insurable via formal insurance markets. In this paper, we consider the use of liquid savings and formal insurance instruments as a combined self-insurance or risk-coping strategy for the minimization of consumption shortfalls caused by

realizations of adverse income shocks. We also consider the role of government safety nets in reducing the need to deplete liquid assets over time in response to such shocks.

In developing countries, exposure to risk remains a significant cause of poverty for poor farmers (Fafchamps, 2010). There is extensive evidence in the existing literature that spatially covariant shocks, such as weather-related events, may impact negatively on human welfare (Alderman et al., 2006; Jacoby and Skoufias, 1997). In addition, idiosyncratic shocks have been found to have negative consequences for households, particularly if shocks are persistent over time (Alderman, 1998; Dercon, 2002; Morduch, 2004; Townsend, 1994; Udry, 1991). The precise nature of the shock incurred will have implications for the household's ability to cope (Dercon, 2002). Idiosyncratic shocks can be insured informally at a community level or via formal insurance contracts, if available, through a third-party insurer. It is not possible to insure collectively against spatially covariant shocks and formal insurance contracts against such risks are rare for reasons of moral hazard and adverse selection. Morduch (2002) claims that the lack of formal insurance, both in terms of market availability and actual take-up, is one of the key drivers of persistent levels of poverty in developing countries. Households living in risky environments must develop alternative strategies to reduce the impact of shocks on their livelihoods (Dercon, 2002). Alderman and Paxson (1994) distinguish between risk-management and risk-coping strategies whereby the former attempt to adjust ex ante the riskiness of the income generating process ('income smoothing') while the latter address the consequences ex post of income shocks ('consumption smoothing'). A considerable body of literature on savings and consumption smoothing explores the concept of precautionary savings. The evidence suggests that in rural populations where credit constraints are binding, inefficient savings behaviour is likely to occur with the savings of many poor households found to be pre-emptive responses to income risk rather than long term investment decisions (Zeldes, 1989; Kimball, 1990; Deaton, 1991, 1992; Udry, 1994).

In this paper, we first present a theoretical model within an inter-temporal utility maximizing framework to explain households' ex ante decisions to insure formally against types of idiosyncratic risk and to precautionary save to protect against uninsurable spatially covariant

risk.[28] Our model predicts that in the absence of formal insurance contracts, a risk-averse household will engage in ex ante precautionary savings strategies to buffer against non-insurable forms of risk. We attempt, therefore, to isolate theoretically the precautionary component of household savings.

Second, using survey data gathered on rural households in Vietnam we examine the effectiveness of the combined risk-coping strategy by first testing the ex post responsiveness of household food consumption growth to adverse idiosyncratic and covariant income shocks. This particular analysis resonates with that developed by Cochrane (1991) who argues that under full insurance, consumption growth should be cross-sectionally independent of idiosyncratic variables that are exogenous to households. Third, we consider the inter-temporal impacts on household liquid assets of such intra-temporal consumption smoothing efforts by examining savings responses to income shocks over time along with formal insurance claims as a combined risk-coping strategy. We estimate reduced form fixed effects models to ascertain the extent to which liquid assets are depleted over time in direct response to spatially covariant and idiosyncratic shocks. We consider different strategies for asset accumulation including financial (currency or gold) savings, livestock and crop stores. We also consider whether households access credit. The model captures the role of formal insurance (empirically disaggregated across free public and voluntary components) together with public and private transfers in buffering against the impact of shocks and preserving valuable asset holdings over time. To our knowledge, this is the first empirical study to incorporate both formal insurance and savings instruments as combined risk-coping mechanisms in the face of disaggregated adverse income shocks within a developing country context.

Our data come from the Vietnamese Access to Resources Household Survey for 2006, 2008 and 2010 and include detailed information on households' financial resources, access to and purchase of formal insurance, and the incidence of categories of both idiosyncratic and spatially covariant shocks. Our application to panel data from Vietnam provides us with a unique opportunity to include both formal insurance and liquid asset savings in the analysis

[28] While insurance against spatially covariant risk, e.g. weather insurance, is available in some developing countries, in many cases supply side constraints, as well as credit constraints and trust, are significant barriers to the uptake of insurance of this kind (see for example, Cole et al. (2010)). In Vietnam, formal insurance for covariant risk is not available to the households in our sample and so is considered an uninsurable, in a formal sense, type of risk.

given that insurance for certain types of idiosyncratic risk using voluntary formal insurance contracts is available to households contained in our dataset.

We find that idiosyncratic and covariant income shocks only result in falls in consumption growth for households that experience persistent shocks. In order to protect consumption, households deplete liquid assets, in particular financial savings, and also accumulate credit. Free public insurance and external transfers assist in preserving cash holdings for some households. Our results lend support to the theory that exposure to risk may induce households to precautionary save, which has important policy implications. Households who save to protect against future income variability will consume less and invest less in potentially productive activities than would be the case in the absence of uncertainty. We find that formal insurance markets are inefficient since voluntary insurance does not materially benefit households in the event of adverse insurable income shocks. We do find, however, that public insurance preserves valuable financial savings suggesting that developing an efficient insurance market has the potential to improve welfare by reducing the need to precautionary save together with facilitating both intra-temporal *and* inter-temporal consumption smoothing efforts.

The remainder of the paper is organized as follows: Section 2.2 details the conceptual framework underlying our main hypotheses; Section 2.3 outlines the empirical approach; Section 2.4 describes the data; Section 2.5 discusses the empirical findings; and Section 2.6 concludes.

2.2 Conceptual Framework

In this section, we present a simple two-period model incorporating both covariant and idiosyncratic risk that captures, in a stylized manner, the formal insurance and savings decisions made by households in anticipation of income shocks.[29] We first present the case where no formal insurance market exists but assume that households can accumulate precautionary savings in order to protect themselves against income variability. We then consider the case where formal insurance markets exist and households can utilize savings

[29] This conceptual framework appeals to the simplicity and tractability of a two-period model framework. This simplicity allows inter-temporal decisions to be modelled whereby the first period represents the current period (or today) while the second period represents the future (or tomorrow). This simple interpretation also facilitates a panel empirical analysis where lifecycle consumption and savings behaviour are explicitly considered.

and activate insurance claims to cope with ex post realizations of risk. Formal insurance decisions are modeled separately from savings decisions and it is explicitly assumed that the idiosyncratic household risk under consideration is completely transferable to a third party insurer while the spatially covariant risk is not, as is consistent with the formal insurance market in Vietnam. The primary goal of this model is to determine optimal savings for the household when savings instruments, together with formal insurance instruments, are available.[30]

Our theoretical framework combines an approach developed by Ventura and Eisenhauer (2005), who theoretically model the decision to precautionary save in the face of adverse income shocks, with Fafchamps (2010) who models the savings and investment decisions of households when securities for risk-transfer are available. We assume a representative household receives a wealth endowment, W, in each period and has a utility function, U where $U'(W)>0$, $U''(W)<0$ and $U'''(W)>0$, so that households are risk averse and have precautionary savings motives. Future wealth is uncertain due to the presence of both covariant and idiosyncratic risk. We first consider a situation where formal insurance markets do not exist. In this case, the household will choose savings level, A to maximize expected utility given in equation (1):

$$MaxU_A = U(W-A)+\beta EU(\tilde{\alpha}W-\tilde{\gamma}+A(1+r)) \qquad (1)$$

where r represents the risk free rate of return and β represents the discount factor. The random variable $\tilde{\alpha}$ represents an exogenous covariant wealth shock (for example, floods, drought, crop disease) with mean $\alpha<1$ and variance σ_α^2, while the random variable $\tilde{\gamma}$ represents an idiosyncratic income shock (for example, injury or illness of a household member), with probability distribution $(\gamma_1 p_1, \gamma_2 p_2, \ldots, \gamma_n p_n)$ with each $\gamma_n \geq 0$ for all losses and with $E[\tilde{\gamma}]=\gamma$ and $V[\tilde{\gamma}]=\sigma_\gamma^2$.[31] The covariant multiplicative shock, $\tilde{\alpha}$, captures the fact that natural shocks (for example, floods, drought etc) together with economic shocks (for

[30] We assume that credit constraints are not binding which facilitates inter-temporal consumption smoothing. This is consistent with credit markets in rural Vietnam where very few households report being credit constrained. This is in part due to the provision of preferential credit for poor households with the overall aim of poverty reduction.

[31] Ventura and Eisenhauer's (2005) model is relevant for developed country contexts where both uncertainty about the level of retirement income ($\tilde{\alpha}$) and uncertainty about other types of income shocks such as ill health or unemployment ($\tilde{\gamma}$) are considered.

example, price shocks) could deplete the households' wealth holdings in the second period. The First Order Condition is given in equation (2):

$$U'(W-A) = \beta(1+r)EU'(\tilde{\alpha}W - \tilde{\gamma} + A(1+r)) \qquad (2)$$

Equation (2) reflects the standard theoretical result that households will precautionary save to protect themselves against future variability in wealth. Assuming that $r=0$ and $\beta=1$ to eliminate any additional inter-temporal motive to save we derive an approximation for the level of precautionary savings A by expanding marginal utility in a Taylor series around wealth and solving equation (2) for A to yield equation (3):[32]

$$A \cong \frac{W(\alpha-1)+\gamma}{2} + \frac{\varphi\sigma_{\gamma}^2}{4-2\varphi W(\alpha-1)+2\varphi\gamma} + \frac{\varphi W^2\sigma_{\alpha}^2}{4-2\varphi W(\alpha-1)+2\varphi\gamma} \qquad (3)$$

where $\varphi = -U'''(W)/U''(W)$ is the coefficient of absolute prudence. Assuming the approximation is local, the first term on the right hand side of equation (3) can be interpreted as an inter-temporal motive for savings implying that in the first period households will save half of their total expected wealth over the two time periods in order to smooth wealth (or consumption). The second and third terms isolate the precautionary motive for saving due to the income uncertainty associated with spatially covariant and idiosyncratic risk. Households will precautionary save to protect against this income uncertainty which will reduce their level of consumption in the first period and will divert resources from other types of productive investments. This can be interpreted as the cost of self-insurance as formal insurance contracts are not available to the household.

We now introduce insurance into the model. Insurance to protect against forms of idiosyncratic risk $\tilde{\gamma}$, is modeled with reference to Gollier (1994), Briys (1986) and Dionne (2000) whereby households have the opportunity to purchase formal insurance contracts

[32] This approach follows Ventura and Eisenhauer (2005). We also impose a mean preserving spread as per Ventura (2007) to ensure that second period expected future wealth remains constant in order to eliminate any additional inter-temporal motive to save. A full derivation is presented in Appendix 2.1, Section 2.1.1. We also acknowledge the limitations of Taylor series approximations of expected utility as discussed by Hlawitschka (1994) who argues that their usefulness is strictly an empirical issue and unrelated to the properties of convergence of the infinite series. Here, we assume our theoretical analysis is locally stable and appeal more to the empirical predictions arising from our Taylor series expansion of expected utility rather than to the quality of the approximation itself.

which consist of a generalized indemnity function $D(.)$ such that the household receives payment $D(\tilde{\gamma})$ in the event of a realized idiosyncratic loss $\tilde{\gamma}$. It is assumed that the premium per unit coverage for a given indemnity function takes the form $\pi = \theta E[D(\tilde{\gamma})]$ where $\theta \geq 1$ is a loading factor. A risk averse utility maximizing household will not purchase full insurance coverage if the insurance premium includes a positive proportional loading to cover administration costs.[33] For ease of illustration we assume that all households have access to insurance markets and are not constrained by liquidity or information.

Letting $D(\gamma) \cong I\gamma$ implies a premium rate $\pi = I\theta E[\tilde{\gamma}]$ where I represents the proportion of the idiosyncratic risk that is covered by the insurance contract. In this two period inter-temporal setting, we assume that households pay the premium in the first period in order to claim against the second period expected idiosyncratic income losses. Following Fafchamps (2010), the insurance contract can be incorporated into the model as in equation (4):

$$Max U_{A,I} = U(W - A - I\theta E(\tilde{\gamma})) + \beta E U(\tilde{\alpha} W - \tilde{\gamma} + A(1+r) + I\tilde{\gamma}) \qquad (4)$$

The two First Order Conditions for insurance coverage I and savings A are given by equations (5) and (6), respectively.

$$U'(W - A - I\theta E(\tilde{\gamma})) = \beta\theta^{-1} E U'(\tilde{\alpha} W - \tilde{\gamma} + A(1+r) + I\tilde{\gamma}) \qquad (5)$$
$$U'(W - A - I\theta E(\tilde{\gamma})) = \beta(1+r) E U'(\tilde{\alpha} W - \tilde{\gamma} + A(1+r) + I\tilde{\gamma}) \qquad (6)$$

Equation (5) states that households will choose insurance coverage I to equate current period marginal utility of consumption with next period discounted expected marginal utility of wealth. According to standard insurance theory, the presence of the loading factor θ requires actuarially fair pricing, $\theta = 1$, in order for the household to purchase full insurance, $I = 1$. Insurance coverage I decreases in θ (for values of θ greater than one) and reduces to $I = 0$ for sufficiently large θ values. For $I = 0$ the model reduces to that given in equation (1) and indicates full *self*-insurance where all idiosyncratic risk together with spatially covariant risk is borne in full by the household.[34] As before, assuming that $r = 0$ and $\beta = 1$, we derive an

[33] For an overview of this literature see for example, Arrow (1963), Mossin (1968) and Smith (1968).

[34] Implicit in this statement is household risk aversion, whereby the greater is household risk-aversion (in absolute terms) the greater is the change in marginal utility (with consumption) and hence the greater is the motivation for consumption smoothing and insurance. When the insurance premium is sufficiently large such

approximation for the level of household savings A by expanding marginal utility in a Taylor series around wealth and solving equation (6) for A to yield equation (7).[35]

$$A \cong \frac{W(\alpha-1)+\gamma}{2} - I\gamma + \frac{\phi\sigma_\gamma^2(I-1)^2}{4-2\phi W(\alpha-1)+2\phi\gamma} + \frac{\phi W^2\sigma_\alpha^2}{4-2\phi W(\alpha-1)+2\phi\gamma} \qquad (7)$$

The first term in equation (7) is the same as the first term in equation (3) and the fourth term in equation (7) is the same as the third term in equation (3). The presence of formal insurance reduces the need to precautionary save through two mechanisms. First, as indicated by the second term on the right hand side of equation (7), purchasing insurance in the first period against the idiosyncratic portion of risk reduces the need to save that amount in order to smooth consumption. This will have no effect on consumption in the first period; it simply means that households will use insurance rather than savings to cover the idiosyncratic portion of their exposure to risk.[36] Second, as indicated by the third term on the right hand side of equation (7), purchasing insurance against the idiosyncratic portion of risk in the first period, reduces the uncertainty of income due to idiosyncratic shocks in the second period for values of $0 < I < 1$, and eliminates it completely with full insurance, $I = 1$. Given that formal insurance reduces the need for households to precautionary save against idiosyncratic risk, this could result in higher first period household consumption outcomes and/or increased productive investment by the household conditional on 1) household preferences, 2) the true subjective discount factor and 3) the real rate of return.

In sum, the fact of being insured is important for ex ante savings behavior in the face of income risk as illustrated by equation (7). By extension, the associated insurance claims are important for ex post household risk-coping in the event of adverse income shocks. It is against this ex post backdrop that we conduct our empirical analysis.

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that the utility gained from income (net of premium) is less than (or equal to) the expected utility of bearing the risk, the household will bear the risk in full.

[35] A full derivation is presented in Appendix 2.1 which accompanies this chapter. For ease of illustration, equation (7) incorporates an actuarially fair loading factor. The derivation of savings 1) that does not include insurance is presented in section 2.1.1 (of Appendix 2.1); 2) that includes formal insurance and an actuarially fair loading is presented in section 2.1.2 (of Appendix 2.1) and 3) that includes formal insurance and variable loading is presented in section 2.1.3 (of Appendix 2.1).

[36] As already noted by Dionne and Eeckhoudt (1984) and Gollier (1994), it does not hold that for non actuarial premia formal insurance is always more efficient than asset accumulation/savings however we assume this to be the case in our model.

2.3 Empirical Considerations

The theoretical predictions from Section 2.2 can be summarized as follows. First, households will save and purchase formal insurance in order to protect consumption from adverse income shocks both across time and across states of nature. In this way, the presence of savings and formal insurance, acting as risk-coping instruments, should together serve to absorb at least some realizations of adverse income risk and therefore consumption should not vary either over time or *across* households ex post in direct response to formally insured idiosyncratic shocks. Second, the presence of liquid savings can only dampen the response of consumption to covariant (and uninsured idiosyncratic) income shocks due to the associated impacts on household lifetime wealth.[37] Third, households with formal insurance will deplete their liquid savings in response to income shocks to a lesser extent over time than those without formal insurance. Other government social safety nets are expected to operate in a similar way. Our ex post empirical investigation thus focuses on the following: the degree to which idiosyncratic and covariate income shocks affect consumption growth across households; the role of household liquid savings in this process over time; and whether the presence of formal insurance and other transfers reduce the depletion of these savings in the event of an income shock.

Our data facilitate the disaggregation of overall shocks into their exogenous (spatially covariant) and idiosyncratic components. Exogenous uninsurable covariant shocks are further disaggregated into 1) economic (for example, crop price changes, key input price changes/shortages) and 2) natural (for example, floods, typhoons, droughts etc) components while our raw data motivate the classification of idiosyncratic shocks as 3) insurable (for example, illness, injury or death of household member) and 4) uninsurable (for example divorce, family disputes etc).[38]

First, by way of additional motivation towards our main exploration of liquid asset responses to income shocks (and whether formal insurance dampens these), we consider whether

[37] Our simple two-period model abstracts from other factors that affect consumption growth, such as the difference between the interest rate and the discount rate (we assume that, $\beta(1+r)=1$) and the inter-temporal elasticity of substitution. We therefore theoretically assume that it is optimal for the household to equate marginal utilities and therefore consumption *levels* over time.

[38] Markets for formal health insurance and life insurance are available to households in our sample. In addition, households can purchase fire insurance and education insurance. Hence, we consider idiosyncratic events such as illness, injury and death to be 'insurable' in this context while other idiosyncratic events such as divorce and family disputes are 'not insurable' due to missing insurance markets.

household food consumption expenditures are directly responsive to adverse income shocks. Although we align this part of our empirical analysis with that of Cochrane (1991), our point of departure is to specifically consider *both* idiosyncratic and covariant shocks and their associated consumption impacts given the underlying presence of formal insurance together with liquid asset savings as a combined risk-coping mechanism in an effort to smooth household consumption over states of nature.[39] Here we also differentiate from the permanent income hypothesis which studies households' ability to smooth consumption over time. Household consumption across states of nature is therefore predicted to be fully protected from insured idiosyncratic income shocks and subject to some adjustments to uninsured idiosyncratic and covariant income shocks – even if only to their permanent components. To test these predictions we apply a variant of the empirical specification developed by Cochrane (1991) and estimate the following cross-sectional regression:

$$log\left(\frac{C_{it+1}}{C_{it}}\right) = \alpha + \beta_1 dNat_{it+1} + \beta_2 dEcon_{it+1} + \beta_3 dIdioI_{it+1} + \beta_4 dIdioU_{it+1} + \boldsymbol{X'_{it+1}\beta_5} + \varepsilon_{it+1} \quad (8)$$

where C_{it+1}/C_{it} is household i's food consumption growth between period t and t+1, $dNat_{it}$, $dEcon_{it}$, $dIdioI_{it}$ and $dIdioU_{it}$ are indicators for the occurrence of spatially covariant natural and economic and idiosyncratic insurable and uninsurable shocks, respectively. We present tests for independence of the shock indicators from consumption growth and discuss the likely bias of the estimated coefficients where applicable. As sources of household heterogeneity appear in the error term ε_{it+1} of equation (8) we exclude income and other decision variables from the right-hand side. Hence, we specify that all right hand variables should not be decision variables and should be exogenous to the household. We do however include the growth in total family income and the growth in household size in vector $\boldsymbol{X_{t+1}}$ together with binary district controls. We argue, as does Cochrane (1991), that these variables are at least plausibly better right hand variables than reported income. We would expect $\beta_3 = 0$ if full consumption insurance is present across states of nature and $\beta_1 = \beta_2 = \beta_4 = 0$ only if other risk-coping devices permit small but insignificant downward adjustments to the

[39] We emphasise the distinction also raised by Cochrane (1991) that consumption insurance and self-insurance are alternatives, with the former facilitated through insurance markets for idiosyncratic income shocks and the latter by liquid savings for covariate income shocks. Within this context, households make use of *both* mechanisms.

permanent components of consumption. Taken together, these results will provide some evidence of the effectiveness of households combined savings and insurance risk-coping devices.[40]

We now turn to the second and most significant part of our empirical investigation which explores the underlying mechanism of consumption protection invoked by the household. We postulate that efforts to smooth consumption intra-temporally via dissaving have adverse implications for the trajectory of liquid asset holdings over time and so test the degree of responsiveness of household liquid savings to adverse income shocks in an inter-temporal context. We disaggregate savings into a variety of different forms including financial savings, livestock holdings, crop stores and forms of borrowings.[41] We use panel data and a household fixed effects model to identify the relationship between income shocks and the depletion of each type of liquid asset. By their nature, idiosyncratic shocks may be correlated with unobserved household characteristics that affect a household's financial decision making.[42] Using a fixed effects estimation procedure will only eliminate any time invariant unobserved heterogeneity which enters additively, while the inclusion of control variables for wealth, income, education and other household characteristics attempt to capture any remaining time varying heterogeneity. To account for the possibility that liquid assets are measured with multiplicative error we take logs and the full household level fixed effects model is given by:[43]

$$a_{it} = \delta_1 dNat_{it} + \delta_2 dEcon_{it} + \delta_3 dIdioI_{it} + \delta_4 dIdioU_{it} + \delta_5 dIns_{it} + \delta_6 dTr_{it} + \delta_7 dIdioI_{it} \times dIns_{it} + \delta_8 dNat_{it} \times dTr_{it} + \mathbf{Z}_{it}' \boldsymbol{\delta}_9 + v_i + \tau_t + e_{it} \quad (9)$$

where a_{it} represents the log of the level of each type of household liquid savings considered, $\mathbf{Z}_{it}$ represents a vector of time variant household characteristics (including the log of income

[40] In this paper we do not consider risk-sharing between households as a risk coping mechanism (see, for example, Townsend (1994)) but focus instead exclusively on self-insurance and consumption insurance mechanisms.

[41] Financial theory suggests that a risk averse household will allocate its total liquid savings over different asset classes as a function of excess returns over the risk-free rate, the coefficient of absolute risk aversion and the variance-covariance of asset returns (see Connor et al. (2009), page 18 for details).

[42] For example, households that suffer the death of a family member may have already begun depleting liquid asset stocks if that household member required medical treatment for some time in advance of his or her death. Moreover, illness could alter the household's marginal utility of consumption by pulling valuable resources away from profitable agricultural (and other) activities. Along with household fixed effects we also control for shock persistence in an attempt to eliminate this potential source of endogeneity.

[43] Paxon (1992) uses a similar approach to estimate the response of savings to transitory income shocks in Thailand.

and wealth levels which act as a proxy for time variant household risk aversion), and e_{it} is a statistical noise term. We assume that the variance of the spatially covariant risk perceived by each household, $\sigma^2_{\alpha i}$, together with household perceptions surrounding any uninsured portion of idiosyncratic risk, $\sigma^2_{\gamma i}$, is subsumed within the household fixed effect v_i together with any regional differences which control for insurance supply side variations and asset pricing variations across regions (including variance/co-variances of asset returns). The time dummies τ_i control for average changes in asset values over time.[44]

Given our theoretical prediction that risk-averse households will insure a portion of the idiosyncratic risk they face, our ex post empirical model includes the binary variable $dIns_{it}$ which indicates whether the household made any insurance claims during the time period.[45] We also include an interaction term between making a claim and experiencing an idiosyncratic insurable shock, $dIdioI_{it} \times dIns_{it}$ which captures the effect on household liquid asset levels of suffering an idiosyncratic insurable shock *and* making an insurance claim. Our hypothesis is that the estimated coefficients on both the level and the interaction term will be significant with the interaction term signaling the degree to which insurance claims serve to reduce the depletion of the liquid savings in response to an income shock.

Our analysis is further extended to consider the extent to which other risk-coping strategies may serve to lessen the depletion of liquid assets. We consider public and private transfers through the dummy variable dTr_{it} as an alternative way to protect consumption in the face of an adverse income shock. Government aid programs in the form of social relief in the case of natural disasters may act as an important safety net for those households suffering spatially covariant natural shocks and this effect is captured through the interaction term $dNat_{it} \times dTr_{it}$. If external transfers help to lessen the depletion of liquid asset holdings in the event of an

[44] We are therefore assuming homogeneous risk preferences within this context. This is in part motivated by the results of a detailed analysis of income smoothing mechanisms where inferences regarding differences in risk preferences appeared to be dominated by the effects of household constraints. The results of this study are presented in Chapter 3.

[45] It is possible that the unobserved factors determining the level of asset accumulation/depletion (such as, for example, the households level of financial knowledge) are correlated with the decision of the household to make an insurance claim. The inclusion of household fixed effects and time varying household characteristics will control for this to some extent. We therefore acknowledge that the insurance results suffer from potential bias due to the observational nature of the data.

adverse natural shock we would expect the coefficient on this interaction term to be positive and statistically significant.

2.4 Data

The data are taken from the Vietnam Access to Resources Household Survey (VARHS) for 2006, 2008 and 2010 (CIEM et al., 2007; 2009; 2011). This survey was carried out in rural areas of 12 provinces of Vietnam in June, July and August of each year producing a balanced panel of 2,045 households spread over 161 districts and 456 communes. The VARHS explores issues surrounding Vietnamese rural households' access to resources and the constraints that households face in managing their livelihoods. Along with detailed demographic information on household members, the survey includes sections on household assets, savings, credit, formal insurance, shocks and risk-coping.

The dependent variable presented in empirical equation (8) captures household food consumption expenditure *growth* from the previous time period to the current period. As such, we measure the levels of household food consumption expenditure (from which the growth rate is derived) as the total monetary value ('000 VND) of a selected number of food items consumed during the previous four weeks before each tranche of the survey was conducted (adjusted to 2010 present values using inflation data from the General Statistics Office, Vietnam). These include food items exchanged, home-produced, or received for free. Hence the food consumption growth dependent variable suffers from the data constraint that representative household consumption throughout the year is not being fully captured. Table 2.0 below provides some descriptive data on household food consumption levels and growth rates across years and across wealth groups.

Table 2.0: Household Food Consumption data

Levels ('000VND)	**2010**			**2008**			**2006**		
Food consumption	956			1045			737		
Food consumption – wealth groups	***W1***	***W2***	***W3***	***W1***	***W2***	***W3***	***W1***	***W2***	***W3***
	632	958	1277	660	1034	1442	416	692	1103
Growth Rates	**2010**			**2008**			**2006**		
Food consumption	1%			33%			-		
Food consumption – wealth groups	***W1***	***W2***	***W3***	***W1***	***W2***	***W3***	***W1***	***W2***	***W3***
	9%	0%	-5%	27%	36%	37%	-	-	-

The dependent variable presented in empirical equation (9) represents the *monetary* value ('000 VND) of each category of household liquid assets under empirical consideration. Each category of household liquid assets is constructed as a monetary variable and grouped in the following way: 1) total liquid assets including total savings (both formal and informal instruments), total livestock (including cows, buffalo, horses, pigs, chicken, ducks, quail), total crop stores (including rice and other crops) and total borrowing (including both formal and informal credit instruments); 2) total livestock representing total livestock values only; 3) total savings representing total household formal (includes savings held with state owned commercial banks, private banks or credit organizations) and informal (includes money held in ROSCAs, cash/gold/ jewellery held at home and savings held with a private moneylender) savings only; 4) total cash/gold/jewellery representing forms of informal liquid saving held at home; 5) total crop stores representing stores of rice and other unspecified crops and 6) total borrowing representing formal and informal household credit instruments. All six dependent variables are inflation adjusted to 2010 present values using external data from the General Statistics Office of Vietnam.

The set of explanatory variables together with the dependent variables used in this analysis is described in Table 2.1.

Table 2.1: Variables and descriptions

Dependent Variable	Variable Label	Description
Household Food Consumption Growth	$\frac{C_{it+1}}{C_t}$ equation (8)	Growth rate derived from the change in the level of household food consumption expenditure from period $t-1$ to period t. The level of food expenditure per household is constructed as the total monetary value ('000 VND) of a selected number of food items consumed during the previous four weeks before each trance of the survey was conducted (adjusted to 2010 present values using GSO Vietnamese inflation data). These include food items exchanged, home-produced or received for free.
Household Total Liquid Assets (level)	Derived from a_{it} equation (9)	Present monetary value ('000 VND) of total liquid assets including total savings (both formal and informal instruments), total livestock (including cows, buffalo, horses, pigs, chicken, ducks, quail), total crop stores (including rice and other crops) and total borrowing (including both formal and informal credit instruments) (adjusted to 2010 present values using GSO Vietnamese inflation data).
Household Total Livestock (level)	Derived from a_{it} equation (9)	Present monetary value ('000 VND) of total livestock including cows, buffalo, horses, pigs, chicken, ducks, quail (adjusted to 2010 present values using GSO Vietnamese inflation data).
Household Total Savings (level)	Derived from a_{it} Equation (9)	Present monetary value ('000 VND) of total formal (including savings held with state owned commercial banks, private banks or credit organizations) and informal (includes money held in ROSCAs, cash/gold/jewellery held at home and savings held with a private moneylender) savings only (adjusted to 2010 present values using GSO Vietnamese inflation data).
Household Cash/Gold/Jewellery (level)	Derived from a_{it} equation (9)	Present monetary ('000 VND) of total cash/gold/jewellery representing forms of informal liquid saving held at home (adjusted to 2010 present values using GSO Vietnamese inflation data).
Household Crop Stores (level)	Derived from a_{it} equation (9)	Present monetary ('000 VND) of total crop stores representing stores of rice and other unspecified crops (adjusted to 2010 present values using GSO Vietnamese inflation data).
Household Total Borrowing (level)	Derived from a_{it} equation (9)	Present monetary ('000 VND) of total borrowing representing formal and informal household credit instruments (adjusted to 2010 present values using GSO Vietnamese inflation data).
Explanatory Variable	**Variable Label**	**Description**
Exogenous: Spatially Covariant Natural Shock	$dNat_{it}$ equation (9)	Dummy variable indicating whether the household has suffered a spatially covariant natural income shock. Shocks include floods, landslides, typhoons, storms, droughts, pest infestation, crop disease and avian flu.
Exogenous: Economic Shock	$dEcon_{it}$ equation (9)	Dummy variable indicating whether the household has suffered an exogenous economic shock. Shocks include changes in crop price, changes in key input prices, changes in prices of food or other essential commodities consumed.
Idiosyncratic: Insurable Shock	$dIdiol_{it}$ equation (9)	Dummy variable indicating whether the household has suffered an idiosyncratic insurable income shock. Shocks include illness, injury or death of a family member.
Idiosyncratic:	$dIdioU_{it}$ equation (9)	Dummy variable indicating whether the household has

Uninsurable Shock		suffered an idiosyncratic uninsurable income shock. Shocks include unemployment, unsuccessful investment, loss of land, crime/robbery/theft, divorce, family disputes.
Transfers	dTr_{it} equation (9)	Dummy variable indicating whether the household has received external income transfers from government and/or family members/relatives (public/private sources).
Insurance Claim	$dIns_{it}$ equation (9)	Dummy variable indicating whether the household has made an insurance claim and received funds in compensation. Claims are restricted to health and life insurance.
Income	Element of vector $\boldsymbol{Z}_{it}$ equation (9)	Household income – includes income from non-farm activities and income from the sale of assets. Although income from the sale of assets is a one off source, excluding it makes no significant difference to the estimation results as only 5% of households reported income from this source in 2010 and 2006 with 7% in 2008. Excludes insurance premium paid. Adjusted to 2010 present values using GSO Vietnamese inflation data. (2010 mean = 80991 VND, 2010 std deviation=130050 VND)
Household Size	Element of vector $\boldsymbol{Z}_{it}$ equation (9)	Total number of household members.
Education of Household Head		1 "Cannot read and write" 2 "Can read & write but did not finish primary school" 3 "Finished primary school" 4 "Finished lower secondary school" 5 "Finished upper secondary school" 6 "Third Level"
Gender of Household Head	Element of vector $\boldsymbol{Z}_{it}$ equation (9)	Dummy variable (1 Male, 0 Female).
Age of Household Head	Element of vector $\boldsymbol{Z}_{it}$ equation (9)	Measured in years.
Wealth	Element of vector $\boldsymbol{Z}_{it}$ equation (9)	Total household wealth constructed using fixed asset values (land), liquid asset values (livestock, savings, crop stores), housing values , equipment and machinery and consumer durables. Liquid Asset values are excluded for the purposes of the analysis. (2010 mean = 351658 VND, 2010 std deviation=1365008 VND)
Recovered from Shocks	Element of vector $\boldsymbol{Z}_{it}$ equation (9)	Dummy variable indicating whether the household has recovered from all income shocks in the current time period.

Information on shocks is gathered directly from households. Households are asked to rank the shocks suffered in order of importance and to provide an associated monetary loss in terms of Vietnamese Dong (VND).[46] Table 2.2 provides a more detailed breakdown of the incidence of income shocks along with a disaggregation across wealth groups.[47]

[46] We validate our data on covariant shocks using information gathered from commune officials on the incidence of different types of natural disasters in the commune. We find that the number of communes with households that reported natural disasters is lower than the number of communes where officials report a natural disaster having occurred. There are almost no cases where households in a commune report natural disasters and

Table 2.2: Household Shocks and Recovery

	2006			2008			2010		
Shock	Households		Recovered	Households		Recovered	Households		Recovered
Any Shock	42%		60%	56%		45%	50%		53%
of which:									
Spatially covariant only	54%		67%	73%		48%	71%		57%
Idiosyncratic only	35%		55%	13%		49%	13%		36%
Both	11%		42%	13%		29%	16%		49%
	WG 1	WG 2	WG 3	WG 1	WG 2	WG 3	WG 1	WG 2	WG 3
Shock	47%	43%	36%	57%	61%	51%	50%	55%	47%
Recovered	52%	61%	71%	41%	49%	47%	44%	52%	62%

Note: WG stands for Wealth Group

Our data reveal that 42 percent of households suffered an adverse income shock between 2004 and 2006, 56 percent between 2006 and 2008 and 50 percent between 2008 and 2010. The magnitude of the impact of shocks ranges from average losses of 30 percent of annual income for poorer households to 37 percent for the wealthiest. It is also clear that covariant shocks are much more prevalent than idiosyncratic shocks. When households were asked whether they fully recovered from shocks suffered, in 2006, 60 percent report that they had compared with 45 percent and 53 percent in 2008 and 2010, respectively. Recovery is less likely where households experience both covariant and idiosyncratic shocks. Disaggregating the household shock and recovery data across wealth groups reveals that in all years, households in the wealthiest group suffer the least from income shocks and are also more likely to recover. These data suggest that while income shocks are problematic for households in all wealth groups, recovery is more difficult for poorer households.[48]

Table 2.3 describes the disaggregated savings in liquid assets of households and how they are accumulated or depleted for households suffering shocks. Table 2.3.1 provides descriptive data on the average levels of household asset holdings. We find that the proportion of households with financial savings increased between 2006 and 2010 from 61 percent to 72 percent of households.[49] The proportion of households with other types of liquid asset

officials report that there were none. If anything, our household data potentially underestimate the incidence of natural disasters.

[47] The household wealth measure includes 1) the sales value of all household plots of land (both owned and operated and rented out) , 2) the sales value of household equipment and machinery, 3) the sales value of consumer durables (excluding housing). All values are expressed in VND ('000) and are adjusted to 2010 present values. This wealth measure used is effectively a *net* wealth measure as it excludes livestock values, crop store values and all forms of savings values which act as dependent variables in the precautionary savings analysis.

[48] We also disaggregate by age group (young and old) but do not find any differences in the incidence of shocks or households' coping ability. These results are presented in Table 2.2.1 of Appendix 2.2 which accompanies this chapter.

[49] In 2008 only 52 percent of households had savings which may reflect the food price crisis in that year and the inflation which followed.

holdings is relatively similar in each year while the proportion of households with loans fell between 2006 and 2010.

Table 2.3: Household Liquid Asset Holdings

	Savings		Livestock		Crops		Loans	
% of hhs								
2006	61%		77%		71%		54%	
2008	52%		68%		69%		41%	
2010	72%		69%		69%		45%	
Change 06-08	No Shock	Shock	No Shock	Shock	No Shock	Shock	No Shock	Shock
'000VND	3,842	-1,079	5,755	8,053	1,890	3,787	24	3,906
Change 08-10	No Shock	Shock	No Shock	Shock	No Shock	Shock	No Shock	Shock
'000VND	7,923	3,715	-1,054	-1,903	-2,902	-1,859	-1,718	2,103

Table 2.3.1: Average Household Liquid Asset Holdings – Levels ('000 VND)

	Savings	Livestock	Crops	Loans
2006	14,835	5,796	1,928	10,774
2008	15,911	8,876	4,884	12,982
2010	21,723	9,551	2,505	13,181

Households that suffered a shock between 2006 and 2008 reduced their savings by an average of 1 million VND while households that did not suffer a shock increased their savings levels. In contrast, between 2008 and 2010, all households increase their savings levels on average, but households suffering from shocks increase their stock of savings by less. We also find that the amount of loans outstanding increases for households that suffer shocks which suggests that households may turn to credit in times of financial stress.

One of our core research questions is the extent to which formal insurance protects against idiosyncratic risk, thus alleviating the need for households to deplete assets or accumulate precautionary savings. In recent years, the Vietnamese formal insurance sector has experienced substantial growth in terms of market penetration. The Vietnamese social security system currently includes forms of social insurance and health insurance. Social insurance includes 1) compulsory social insurance (for example, sickness, maternity, occupational disease and accidents, old-age, survival benefits); 2) voluntary social insurance (for example, old-age, survival benefits) and 3) unemployment insurance. Health insurance includes both compulsory and voluntary instruments. Voluntary social insurance is targeted at citizens of working age who do not participate in compulsory social insurance schemes. It is a significant measure which is aimed at extending the coverage of social insurance and supporting the security of income, especially for agricultural workers and informal sector workers. Moreover, the Vietnamese government provides free social insurance and free

health insurance for the poorest families. The data reveal that insurance is held by 82 percent of households in 2010 (see Table 2.4). This includes all types of insurance: voluntary and compulsory. Of those, 24 percent of households hold voluntary insurance contracts that insure them against the types of idiosyncratic risks considered in our empirical analysis (health, life and social), and 29 percent of households hold free insurance provided by the government (health and social). While over time the uptake of insurance has increased, the proportion of contracts which are voluntarily purchased is much lower in 2010 compared with 2006. This is most likely due to the introduction of other types of risk coping mechanisms by the Vietnamese government during the time period including direct financial support for households in times of crisis and also an increase in the role and importance of private remittances. As such, we also include in our analysis an indicator for whether households received transfers as an additional risk coping mechanism and consider the extent to which they may substitute for other types of formal insurance in reducing the need for households to deplete assets in the event of an income shock.[50]

Table 2.4: Household Insurance

	Any Insurance	Voluntary Insurance	Public Insurance
		2006	
% with insurance	80%	70%	35%
% claiming		8%	7%
		2008	
% with insurance	75%	34%	49%
% claiming		3%	7%
		2010	
% with insurance	82%	24%	29%
% claiming		2%	7%

Note: Voluntary insurance includes health, life and social insurance while Public Insurance includes free social and free health insurance. Fire, vehicle and education insurance are also included in the 'Any Insurance' category.

It must be emphasised that the raw data do not facilitate a precise linkage between those shocks that are insurable and those shocks that are actually insured (conditional on being insurable). As such, we consider the effect of formal insurance claims on household asset holdings in the event of insurable income shocks in an effort to proxy the effects of those shocks that are actually insured.

[50] While anecdotal evidence suggests that the Vietnamese government provides assistance via transfer payments to households severely affected by natural disasters, the majority of public transfers in our data are in the form of pensions and transfers from children. If households expect transfers in the event of an income shock then they could be viewed as safety-nets that act as a substitute for insurance. It is not clear whether this is the case for our sample of households, although given that there are no insurance products available to protect against income losses associated with natural disasters it is unlikely that the safety-net component of transfers will affect our results.

2.5 Empirical Results

To test the theoretical predictions developed in Section 2.2 our empirical strategy is two-fold. First, we focus on consumption growth responses to the observed categories of adverse income shocks in order to gain an understanding of the extent to which households smooth consumption over states of nature. Second, we explore the underlying mechanism of consumption insurance by examining the depletion of household liquid assets (or dissaving) over time in response to adverse income shocks to determine whether these assets serve precautionary or self-insurance purposes and whether the presence of formal insurance dampens the depletion of these asset holdings in response to such shocks.

2.5.1 Consumption Growth

Our theoretical model predicts that formally insured households will smooth consumption across time and across states of nature regardless of whether or not they suffer an idiosyncratic income shock. Self-insured households (households without formal insurance), on the other hand, will adjust consumption to an idiosyncratic or covariant shock's lifetime income components. As the stylized conceptual model shows, consumption responds to income unless insurance is perfect; savings alone can only dampen the response of consumption to income but cannot eliminate it because, even if a household has savings, a negative shock will slightly reduce the household's lifetime wealth and thus reduces its consumption. Focusing specifically on the degree of household consumption smoothing across states of nature, we estimate equation (8) and the results are presented in Table 2.5.

Table 2.5: Consumption Smoothing Tests (across states of nature)

Independent Variables	***Dependent Household food consumption growth***			
	Full Sample	Lowest Wealth Group	Middle Wealth Group	Highest Wealth Group
	(1)	(2)	(3)	(4)
Shock Persistence	-0.082*	-0.037	-0.092	-0.094
	(0.048)	(0.101)	(0.082)	(0.077)
Exogenous: Natural Shocks	-0.063	0.048	-0.064	-0.122
	(0.055)	(0.098)	(0.086)	(0.077)
Exogenous: Economic Shocks	-0.172	-0.133	-0.205	-0.028
	(0.123)	(0.232)	(0.212)	(0.160)
Idiosyncratic: Insurable Shocks	-0.038	-0.220**	0.094	-0.110
	(0.052)	(0.098)	(0.146)	(0.100)
Idiosyncratic: Uninsurable Shock	-0.042	-0.220	-0.105	0.207
	(0.106)	(0.151)	(0.204)	(0.188)
Income Growth	0.239***	0.316***	0.304***	0.145***
	(0.026)	(0.050)	(0.052)	(0.030)
Growth in Household Size	0.464***	0.475***	0.385***	0.467***
	(0.061)	(0.145)	(0.105)	(0.089)
Wealth Group	Yes			
District Controls	Yes	Yes	Yes	Yes
Constant	0.477***	0.252	0.360**	0.552***
	(0.066)	(0.180)	(0.138)	(0.072)
Observations	2028	674	675	679
R-squared	0.335	0.437	0.405	0.410

Robust standard errors clustered at the district level are given in parenthesis. *** indicates significance at the 1% level, ** indicates significance at the 5% level, * indicates significance at the 10% level.

The results for the full sample of 2010 households presented in column (1) suggest that food consumption growth is insulated from all types of shocks.[51] This suggests that households that experience income shocks draw down on the various consumption insurance and self-insurance mechanisms that they have in place to smooth consumption over states of nature. However, once we include a control for persistence which captures the households that report that they have not fully recovered from current period shocks, we find this persistence has a negative effect on consumption growth with shortfalls of 8 per cent. The probability values for χ^2 tests of independence of consumption growth and each income shock indicator variable confirm independence.[52] Disaggregating the model by wealth group reveals that households in the lowest wealth group suffer consumption growth shortfalls of 22 per cent when exposed to idiosyncratic insurable shocks (Column 2). By contrast, consumption

[51] Household food consumption expenditure is measured as the total monetary value ('000 VND) of a selected number of food items consumed during the previous four weeks (adjusted to 2010 present values). These include food items exchanged, home-produced or received for free.

[52] Tests of independence are carried out at the district level. For those districts where households experienced income shocks χ^2 tests confirm independence of consumption growth and 1) the natural shock indicator for all districts, 2) the economic shock indicator for all districts, 3) the idiosyncratic insurable shock for all districts and 4) the idiosyncratic uninsurable shock for all districts.

growth of the middle and highest wealth group of households appears fully protected from all forms of income shocks (Columns 3, 4). Overall, our results indicate that while some households manage to smooth consumption across states of nature in the event of adverse income shocks, consumption is not fully protected for the poorest households suggesting that risk-coping mechanisms are insufficient to be effective across all wealth groups.[53]

The extent to which households must deplete their stocks of liquid assets over time in response to specific categories of observed income shocks, and the role that formal insurance plays in this process is explored in the second stage of our empirical analysis to which we now turn.

2.5.2 Total Liquid Assets

For each category of savings under consideration (total liquid assets, forms of financial savings, livestock and crop stores), and for borrowing, we estimate the model given in equation (9) including controls for income, wealth, household composition, household fixed effects and time dummies. We first explore whether a household's stock of total liquid assets (including all savings, livestock and crops stores) is responsive to adverse income shocks. The results are presented in Table 2.6 and are also disaggregated by wealth group and age group.

Column (1) reveals a negative and significant relationship between shocks and the depletion of liquid assets. In particular, we find that households suffering exogenous economic shocks reduce their level of total liquid asset holdings by 18 percent and those exposed to idiosyncratic insurable shocks by 14 percent. These results provide some evidence in support of our primary hypothesis that household savings serve precautionary or self-insurance purposes. Interacting voluntary insurance claims with idiosyncratic insurable shocks has no effect, however the interaction term between public insurance claims and idiosyncratic insurable shocks is positive and significant (Column (2)). This suggests that public insurance serves as an important risk-coping mechanism which enables households to accumulate rather than deplete their stocks of total liquid assets in response to insurable income shocks. Also in Column (2), transfers are interacted with idiosyncratic insurable shocks. The interaction term is negative and significant suggesting that households that experience

[53] We also perform this consumption insurance analysis for 2008 households and results do not vary significantly. These results are presented in Table 2.2.2 of Appendix 2.2 which accompanies this chapter.

idiosyncratic shocks and are in receipt of transfers deplete their savings by 37 percent more than other households: in other words, the availability of transfers does not alleviate the need for households to deplete their liquid asset savings in the face of adverse income shocks.

Disaggregating the sample into three wealth groups and running the model separately for each group (Columns (3), (4) and (5)) reveals that exogenous economic shocks are important for the middle wealth group while idiosyncratic insurable shocks are most problematic for the lowest wealth group. Public insurance claims, however, only benefit the middle wealth group suggesting that while on aggregate public insurance is serving a social safety net function it may not be reaching the poorest groups. We also find that the interaction between idiosyncratic shocks and transfers is only negative and significant for the wealthiest group. This suggests that wealthier households that suffer idiosyncratic shocks might draw on many different mechanisms for risk-coping including depleting assets and relying on transfers from others.

Table 2.6: Fixed effects estimates of the impact of income shocks on Total Liquid Asset Holdings

Independent Variables	***Dependent Variable*** ***Level of Household Level of Total Liquid Asset Holdings (Savings, Livestock, Crop Stores)***						
	(1) *Full sample*	*(2)* *Full sample*	*(3)* *Wealth Group 1*	*(4)* *Wealth Group 2*	*(5)* *Wealth Group 3*	*(6)* *Young*	*(7)* *Old*
Exogenous: Natural Shock	-0.027	-0.021	0.081	-0.023	-0.123	-0.037	-0.065
	(0.050)	(0.050)	(0.103)	(0.076)	(0.124)	(0.074)	(0.079)
Exogenous: Economic Shock	-0.188*	-0.188*	0.095	-0.440**	-0.025	-0.317**	0.069
	(0.100)	(0.101)	(0.168)	(0.201)	(0.243)	(0.160)	(0.132)
Idiosyncratic: Insurable Shock	-0.138**	0.097	-0.392**	0.070	0.330	0.081	0.061
	(0.060)	(0.103)	(0.195)	(0.187)	(0.214)	(0.146)	(0.175)
Idiosyncratic: Uninsurable Shock	-0.037	-0.049	0.113	0.047	0.200	-0.012	-0.175
	(0.099)	(0.100)	(0.169)	(0.123)	(0.207)	(0.127)	(0.184)
Voluntary Insurance Claim	-0.080	-0.005	-0.045	-0.202	0.123	-0.032	-0.092
	(0.115)	(0.123)	(0.235)	(0.173)	(0.203)	(0.205)	(0.149)
VolInsClaim* Insurable Shock		-0.279	0.007	0.118	-0.401	-0.696	0.079
		(0.286)	(0.521)	(0.779)	(0.463)	(0.426)	(0.425)
Public Insurance Claim	-0.108	-0.216**	-0.342**	0.052	-0.209	-0.169	-0.268*
	(0.081)	(0.085)	(0.168)	(0.139)	(0.284)	(0.124)	(0.140)
PubInsClaim*Insurable Shock		0.694***	0.496	1.006**	0.572	0.264	0.930***
		(0.211)	(0.330)	(0.455)	(0.716)	(0.375)	(0.279)
Transfers	-0.001	0.040	-0.046	0.080	0.106	0.037	0.055
	(0.040)	(0.043)	(0.090)	(0.072)	(0.103)	(0.061)	(0.069)
Transfers*Insurable Shock		-0.371***	0.047	-0.328	-0.501*	-0.171	-0.418**
		(0.129)	(0.241)	(0.225)	(0.268)	(0.191)	(0.211)
Household Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	5,764	5,764	1,849	1,970	1,945	2,928	2,836
R-squared	0.137	0.141	0.259	0.467	0.089	0.171	0.121
Number of households	2,032	2,032	1,129	1,325	1,198	1,260	1,250

Robust standard errors are clustered at the household level and are given in parenthesis. *** indicates significance at the 1% level, ** indicates significance at the 5% level, * indicates significance at the 10% level.

Note: We do not present results for the interaction between transfers and natural shocks as it is statistically insignificant in all cases.

We cannot disentangle the precise amount of total liquid assets that was originally intended to serve as precautionary savings from the amount serving other inter-temporal purposes. However, in an attempt to identify lifecycle effects, we estimate the model separately for young (head<median age) and old households (head>median age). Our results (Columns 6, 7) indicate that economic shocks (only) deplete the liquid assets of younger households while free public insurance claims are only beneficial for older households.

2.5.3 Livestock Holdings

The results for livestock holdings are presented in Table 2.7. In Column (1) we find that idiosyncratic shocks deplete livestock holdings within households by 15 percent on average. There is no evidence to suggest, however, that livestock acts as a risk-coping mechanism against covariant shocks. Rosenzweig and Wolpin (1993) find a similar result. These findings also support the evidence presented in Fafchamps et al. (1998) and Dercon (2002) which proposes that although livestock are a buffer stock, households resist selling in response to spatially covariant shock where the prices for livestock will most likely fall. Dercon (2001) explains that when a natural crisis hits an area and many households attempt to sell their assets, prices may collapse and greatly reduce the income derived from selling the asset in a time of financial stress. Idiosyncratic insurable shocks, on the other hand, facilitate the use of livestock as a risk-coping mechanism. We find some evidence that this is the case.

Turning our attention to formal insurance effects, we find that making voluntary insurance claims has a negative effect on livestock values but the interaction between idiosyncratic shocks and voluntary insurance is not statistically significant (Column 2). In contrast, we find that public insurance claims reduce the need for households to sell livestock in the event of idiosyncratic insurable shocks. This effect only holds for the middle wealth group (Column 4). This indicates that while households who suffer idiosyncratic insurable income shocks rely on livestock to act as a buffer, those that can claim from their free public insurance policies do not. Disaggregating by the age of the head of household we find that it is only households with younger heads that deplete livestock resources in the event of idiosyncratic insurable shocks. This result suggests that younger households are more willing (or are forced) to sacrifice their livestock assets in order to preserve consumption in the event of idiosyncratic shocks. The insurance and transfer safety nets do not appear to serve as a buffer for these households.

Table 2.7: Fixed effects estimates of the impact of income shocks on Total Livestock Holdings

Independent Variables	***Dependent Variable Household Level of Total Livestock***						
	(1) Full sample	*(2) Full sample*	*(3) Wealth Group 1*	*(4) Wealth Group 2*	*(5) Wealth Group 3*	*(6) Young*	*(7) Old*
Exogenous: Natural Shock	0.010	0.013	0.051	-0.087	0.374**	0.052	-0.119
	(0.065)	(0.065)	(0.159)	(0.114)	(0.177)	(0.100)	(0.105)
Exogenous: Economic Shock	0.023	0.028	0.441	0.382	0.148	0.162	-0.157
	(0.150)	(0.150)	(0.473)	(0.334)	(0.274)	(0.254)	(0.190)
Idiosyncratic: Insurable Shock	-0.154*	-0.065	-0.676*	-0.129	0.541*	-0.053	-0.200
	(0.092)	(0.142)	(0.381)	(0.185)	(0.321)	(0.225)	(0.233)
Idiosyncratic: Uninsurable Shock	-0.104	-0.106	0.418	-0.010	0.133	-0.355*	0.185
	(0.124)	(0.125)	(0.438)	(0.173)	(0.251)	(0.203)	(0.168)
Voluntary Insurance Claim	-0.326*	-0.340*	-0.598	-0.415	-0.229	-0.568*	-0.161
	(0.173)	(0.200)	(0.430)	(0.371)	(0.305)	(0.338)	(0.263)
VolInsClaim* Insurable Shock		0.083	1.304	0.572	-2.047**	0.160	0.183
		(0.429)	(0.939)	(0.635)	(0.802)	(0.498)	(0.743)
Public Insurance Claim	-0.014	-0.093	-0.400	0.016	0.495	-0.119	0.016
	(0.132)	(0.138)	(0.248)	(0.283)	(0.523)	(0.208)	(0.196)
PubInsClaim*Insurable Shock		0.608*	0.562	1.575*	-0.631	0.630	0.477
		(0.368)	(0.656)	(0.876)	(0.972)	(0.635)	(0.415)
Transfers	-0.022	-0.001	0.032	0.063	0.009	-0.003	-0.013
	(0.062)	(0.066)	(0.173)	(0.134)	(0.158)	(0.101)	(0.098)
Transfers*Insurable Shock		-0.184	-0.024	0.088	-0.707	-0.044	-0.042
		(0.182)	(0.475)	(0.276)	(0.438)	(0.290)	(0.293)
Household Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	4,372	4,372	1,396	1,602	1,374	2,299	2,073
R-squared	0.357	0.358	0.456	0.491	0.310	0.380	0.344
Number of households	1,777	1,777	926	1,080	931	1,095	1,036

Robust standard errors are clustered at the household level and are given in parenthesis. *** indicates significance at the 1% level, ** indicates significance at the 5% level, * indicates significance at the 10% level.

Note: Households with no livestock holdings are automatically dropped from the estimation. We do not present results for the interaction between transfers and natural shocks as it is statistically insignificant in all cases.

2.5.4 Financial Savings

In analyzing the extent to which households deplete their financial savings in response to shocks we first consider the household's total stock of savings and also disaggregate savings into formal savings (with financial institutions), informal savings and cash/gold stores held at home. The results for the total savings stocks are presented in Table 2.8.

We find that the occurrence of covariant natural shocks and idiosyncratic insurable shocks deplete households' stock of savings by 19 and 16 percent, respectively. Also of note is the fact that households in receipt of public insurance claims deplete savings by 22 percent. However, the interaction between households that experience idiosyncratic shocks and those that receive public insurance claims is positive, statistically significant and of a very large magnitude (Column (2)). This suggests that having free public insurance eliminates the need to draw down savings stocks in the event of insurable adverse income shocks. When disaggregated by wealth group we find that this effect holds for households in the lowest and middle wealth groups. Once again, there is no evidence that voluntary insurance claims serve as a buffer to preserve savings stocks in times of financial stress (Column (5)).

We also find (in Columns (6) and (7)) that savings are used differently by young and old households. Younger households deplete savings in response to natural shocks while older households deplete savings in response to idiosyncratic insurable shocks. As such, it is only the latter group that benefit from the extra buffer of free public insurance claims. For younger households transfers appear to reduce the need for households to deplete savings in response to natural shocks: when transfers are interacted with natural shocks for younger households we find that savings depletions are reduced by 30 percent. We interpret this result as providing some evidence regarding the importance of external transfers in times of natural disaster, notwithstanding that the magnitude of this assistance appears not to fully compensate for the total financial loss incurred.

Table 2.8: Fixed effects estimates of the impact of income shocks on Total Savings

Independent Variables	***Dependent Variable Household Level of Total Savings***						
	(1) Full sample	*(2) Full sample*	*(3) Wealth Group 1*	*(4) Wealth Group 2*	*(5) Wealth Group 3*	*(6) Young*	*(7) Old*
Exogenous: Natural Shock	-0.195***	-0.267***	-0.287	-0.324*	-0.106	-0.498***	-0.106
	(0.066)	(0.087)	(0.256)	(0.168)	(0.178)	(0.124)	(0.146)
Exogenous: Economic Shock	-0.034	-0.035	-0.417	-0.286	0.410	-0.286*	0.297
	(0.150)	(0.150)	(0.419)	(0.295)	(0.274)	(0.167)	(0.287)
Idiosyncratic: Insurable Shock	-0.164**	-0.218**	-0.971***	-0.404**	0.212	-0.189	-0.256**
	(0.081)	(0.086)	(0.245)	(0.170)	(0.160)	(0.134)	(0.128)
Idiosyncratic: Uninsurable Shock	0.027	0.028	0.369	-0.266	0.232	0.085	-0.245
	(0.142)	(0.142)	(0.481)	(0.269)	(0.255)	(0.187)	(0.202)
Voluntary Insurance Claim	0.079	0.136	1.344***	-0.601**	0.256	0.056	0.179
	(0.125)	(0.125)	(0.445)	(0.293)	(0.193)	(0.184)	(0.189)
VolInsClaim* Insurable Shock		-0.209	-0.389	1.070	0.583	-0.163	-0.186
		(0.386)	(0.695)	(1.746)	(0.548)	(0.625)	(0.595)
Public Insurance Claim	-0.226*	-0.420***	-0.945**	0.152	-0.162	-0.463***	-0.319*
	(0.118)	(0.113)	(0.425)	(0.209)	(0.295)	(0.144)	(0.186)
PubInsClaim*Insurable Shock		1.207***	1.664**	1.721**	0.639	1.007	1.062**
		(0.344)	(0.646)	(0.721)	(0.926)	(0.854)	(0.432)
Transfers	-0.071	-0.134*	-0.365*	0.155	-0.102	-0.244**	-0.066
	(0.057)	(0.069)	(0.207)	(0.152)	(0.133)	(0.096)	(0.104)
Transfers*Natural Shock		0.165	0.127	0.235	0.187	0.305**	-0.033
		(0.100)	(0.302)	(0.227)	(0.171)	(0.146)	(0.169)
Household Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	3,782	3,782	852	1,335	1,595	1,872	1,910
R-squared	0.066	0.074	0.296	0.263	0.100	0.078	0.096
Number of households	1,866	1,866	680	1,033	1,030	1,073	1,087

Robust standard errors are clustered at the household level and are given in parenthesis. *** indicates significance at the 1% level, ** indicates significance at the 5% level, * indicates significance at the 10% level.

Note: Households with no Savings are automatically dropped from the estimation. In this table we present the interaction between transfers and natural shocks as it is statistically significant in some cases. We exclude the specification including the interaction between transfers and idiosyncratic insurable shocks as it is statistically insignificant in all cases.

Disaggregating total savings into its various components also reveals some interesting findings, particularly for cash/gold held at home (see Table 2.9). We find that both natural disasters and idiosyncratic insurable shocks deplete households' stocks of cash/gold held at home.[54] Consistent with the results pertaining to the total stock of saving, we find that free public insurance claims and transfers feature significantly as risk-coping mechanisms in the face of idiosyncratic insurable shocks and natural disasters, respectively, although there is still a shortfall in terms of financial loss for households. Voluntary insurance claims do not ease the depletion of cash/gold in the face of idiosyncratic insurable shocks. We find no evidence that either formal or informal savings serve as important risk-coping mechanisms for households.[55]

[54] It is possible that natural disasters such as flooding might physically destroy the stock of cash and gold held by households. We cannot tell from our data whether or not this is the case.

[55] The results for formal and informal savings are available in Tables 2.2.3 and 2.2.4 respectively of Appendix 2.2 which accompanies this chapter.

Table 2.9: Fixed effects estimates of the impact of income shocks on Cash/Gold held at home

Independent Variables	***Dependent Variable Household Level of Cash/Gold/Jewellery Held at home***						
	(1) Full sample	*(2) Full sample*	*(3) Wealth Group 1*	*(4) Wealth Group 2*	*(5) Wealth Group 3*	*(6) Young*	*(7) Old*
Exogenous: Natural Shock	-0.163**	-0.264***	-0.540*	-0.159	-0.241	-0.296**	-0.305*
	(0.071)	(0.096)	(0.279)	(0.194)	(0.219)	(0.129)	(0.165)
Exogenous: Economic Shock	-0.166	-0.184	-0.059	-0.438	-0.079	-0.490***	-0.044
	(0.144)	(0.145)	(0.590)	(0.367)	(0.223)	(0.177)	(0.270)
Idiosyncratic: Insurable Shock	-0.228**	-0.235***	-0.628**	-0.245	-0.084	-0.210	-0.284**
	(0.089)	(0.091)	(0.264)	(0.184)	(0.186)	(0.132)	(0.140)
Idiosyncratic: Uninsurable Shock	0.041	0.046	0.745*	-0.049	0.248	0.193	-0.306
	(0.157)	(0.157)	(0.420)	(0.352)	(0.287)	(0.192)	(0.229)
Voluntary Insurance Claim	-0.047	0.045	0.987**	-0.736**	0.213	-0.048	0.139
	(0.131)	(0.137)	(0.428)	(0.306)	(0.227)	(0.200)	(0.217)
VolInsClaim* Insurable Shock		-0.342	0.102	0.427	0.317	-0.318	-0.321
		(0.377)	(0.699)	(1.752)	(0.562)	(0.612)	(0.533)
Public Insurance Claim	-0.065	-0.174	-0.676*	0.072	0.340	-0.298*	-0.138
	(0.122)	(0.127)	(0.384)	(0.351)	(0.423)	(0.167)	(0.212)
PubInsClaim*Insurable Shock		0.687**	0.735	1.540	-0.988	-0.811*	0.760*
		(0.337)	(0.484)	(0.965)	(0.751)	(0.416)	(0.404)
Transfers	-0.178***	-0.252***	-0.458*	0.005	-0.334**	-0.270***	-0.259**
	(0.061)	(0.073)	(0.237)	(0.170)	(0.149)	(0.102)	(0.105)
Transfers*Natural Shock		0.199*	0.416	-0.056	0.303	0.185	0.081
		(0.111)	(0.360)	(0.279)	(0.199)	(0.159)	(0.189)
Household Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	3,283	3,283	755	1,171	1,357	1,630	1,653
R-squared	0.053	0.058	0.267	0.236	0.083	0.115	0.088
Number of households	1,790	1,790	618	935	931	1,014	1,010

Robust standard errors are clustered at the household level and are given in parenthesis. *** indicates significance at the 1% level, ** indicates significance at the 5% level, * indicates significance at the 10% level.

Note: Households with no Cash/Gold held at home are automatically dropped from the estimation. In this table we present the interaction between transfers and natural shocks as it is statistically significant in some cases. We exclude the specification including the interaction between transfers and idiosyncratic insurable shocks as it is statistically insignificant in all cases.

2.5.5 Crop Stores

Crop stores in the form of rice, maize, potatoes etc., may also act as a form of precautionary saving. Park (2006) finds that the joint nature of production and savings decisions limits the income loss associated with risk-coping, and the desire to store grain can explain why subsistence households are frequently net purchasers but rarely net sellers of grain. The results for crop stores are presented in Table 2.10.

Our results indicate that, in general, total crop stores are not responsive to idiosyncratic or covariant shocks. Disaggregating by wealth group we find some evidence that households in the middle wealth groups (Column (4)) deplete their stores of crops in the event of uninsurable idiosyncratic shocks adding further support to our theoretical predictions. Moreover, when we disaggregate by the age of the head of household we find that older households deplete their crop stores in the event of natural disasters (Column (7)). For these households risk-coping may simply require that more harvest is domestically consumed to offset the financial losses incurred. We do not find any evidence that other risk coping mechanisms and social security safety nets reduce the need for households to deplete crop stores in the event of shocks.

Overall, while we find some evidence that crop stores are drawn down in times of financial stress for some households, the evidence is scant. Given that anecdotal evidence suggests that rural Vietnamese households do not have the means to store large quantities of their crops (due to the small scale of their production and a lack of storage facilities), it is not surprising that crop stores do not emerge as an important risk-coping mechanism for most households.

Table 2.10: Fixed effects estimates of the impact of income shocks on Crop Stores

Independent Variables	***Dependent Variable Household Level of Crop Stores***						
	(1) Full sample	*(2) Full sample*	*(3) Wealth Group 1*	*(4) Wealth Group 2*	*(5) Wealth Group 3*	*(6) Young*	*(7) Old*
Exogenous: Natural Shock	-0.053	-0.052	-0.062	0.021	-0.260*	0.001	-0.153**
	(0.039)	(0.039)	(0.085)	(0.074)	(0.152)	(0.060)	(0.061)
Exogenous: Economic Shock	-0.045	-0.049	0.085	-0.142	0.098	-0.091	0.048
	(0.081)	(0.080)	(0.221)	(0.139)	(0.320)	(0.110)	(0.130)
Idiosyncratic: Insurable Shock	-0.010	0.099	-0.228	0.194	-0.103	0.168	0.205*
	(0.049)	(0.085)	(0.200)	(0.164)	(0.200)	(0.132)	(0.120)
Idiosyncratic: Uninsurable Shock	-0.062	-0.066	0.122	-0.359**	-0.148	-0.124	-0.010
	(0.083)	(0.083)	(0.140)	(0.158)	(0.225)	(0.112)	(0.121)
Voluntary Insurance Claim	-0.077	0.034	0.107	-0.115	0.220	-0.180	-0.036
	(0.084)	(0.094)	(0.174)	(0.212)	(0.257)	(0.190)	(0.113)
VolInsClaim* Insurable Shock		-0.446**	-0.384	-0.442	-1.187**	-0.086	-0.320
		(0.184)	(0.361)	(0.585)	(0.482)	(0.300)	(0.251)
Public Insurance Claim	0.106	0.107	0.103	0.839***	-0.345	0.104	-0.016
	(0.083)	(0.086)	(0.159)	(0.223)	(0.391)	(0.104)	(0.154)
PubInsClaim*Insurable Shock		0.037	-0.949	-0.184	0.882	0.202	-0.134
		(0.287)	(0.592)	(0.320)	(0.612)	(0.413)	(0.433)
Transfers	-0.112***	-0.099***	-0.118	0.172**	-0.284**	-0.143**	-0.132**
	(0.036)	(0.037)	(0.075)	(0.075)	(0.133)	(0.056)	(0.054)
Transfers*Insurable Shock		-0.126	0.272	-0.204	-0.145	-0.146	-0.239
		(0.108)	(0.211)	(0.221)	(0.286)	(0.160)	(0.166)
Household Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	4,260	4,260	1,476	1,579	1,205	2,203	2,057
R-squared	0.202	0.204	0.234	0.315	0.241	0.228	0.212
Number of households	1,662	1,662	918	1,060	862	1,017	994

Robust standard errors are clustered at the household level and are given in parenthesis. *** indicates significance at the 1% level, ** indicates significance at the 5% level, * indicates significance at the 10% level.

Note: Households with no Crop Stores are automatically dropped from the estimation. We do not present results for the interaction between transfers and natural shocks as it is statistically insignificant in all cases.

2.5.6 Household Borrowing

Finally, we turn our attention to rural credit markets and test whether the existence of credit instruments (or negative assets) serves as a risk-coping mechanism for rural Vietnamese households. According to Dercon (2002), credit and insurance markets in developing economies are typically absent or incomplete, either for good theoretical reasons or as a result of bad policy (for surveys, see Bell (1988) or Besley (1995)). Typically, consumption loans are rare. We use a fixed effects estimation to regress the total outstanding household loan amounts against measures of covariant and idiosyncratic shocks to determine whether the household resorts to borrowing to facilitate consumption smoothing when faced with adverse income shocks. The results are presented in Table 2.11.

We find that total household loan amounts respond positively to all types of adverse income shocks with the exception of endogenous uninsurable shocks. Disaggregating by wealth group we find that using credit in times of financial stress is most common for the poorest households with some evidence that households in the middle wealth group also rely on credit to some extent. Moreover, while both old and young households use credit in the event of shocks, younger households appear to do so to a greater extent. It appears, overall, that rural Vietnamese households resort to increasing their borrowings in times of financial stress. We do not find any evidence that insurance claims or external transfers help to ease households' debt burden. When credit is disaggregated into formal and informal borrowings we find that the reliance on credit is primarily through informal means which may explain why credit is accessible to the poorest.[56]

[56] The disaggregation by formal and informal credit is presented in Tables 2.2.5 and 2.2.6 respectively of Appendix 2.2 which accompanies this chapter.

Table 2.11: Fixed effects estimates of the impact of income shocks on Total Borrowing

Independent Variables	***Dependent Variable Household Level of Total Borrowing***						
	(1) Full sample	*(2) Full sample*	*(3) Wealth Group 1*	*(4) Wealth Group 2*	*(5) Wealth Group 3*	*(6) Young*	*(7) Old*
Exogenous: Natural Shock	0.662***	0.660***	1.354***	-0.056	0.144	0.496**	0.922***
	(0.164)	(0.164)	(0.324)	(0.398)	(0.416)	(0.245)	(0.258)
Exogenous: Economic Shock	0.883***	0.875**	1.008	0.275	-0.472	1.138**	0.740
	(0.341)	(0.342)	(0.801)	(0.755)	(0.931)	(0.468)	(0.563)
Idiosyncratic: Insurable Shock	0.923***	1.260***	1.508**	1.058*	0.031	1.444***	1.266**
	(0.187)	(0.321)	(0.638)	(0.619)	(0.745)	(0.471)	(0.501)
Idiosyncratic: Uninsurable Shock	0.535	0.508	0.211	1.548**	1.050	0.445	0.386
	(0.332)	(0.332)	(0.886)	(0.731)	(0.701)	(0.456)	(0.541)
Voluntary Insurance Claim	-0.177	-0.231	-1.263	0.133	-0.164	-0.051	-0.462
	(0.346)	(0.405)	(0.823)	(1.049)	(0.723)	(0.658)	(0.611)
VolInsClaim* Insurable Shock		0.231	0.498	1.221	0.216	-0.923	1.107
		(0.725)	(1.503)	(1.801)	(1.969)	(1.306)	(0.973)
Public Insurance Claim	0.579*	0.655**	-0.206	0.049	1.119	1.127**	0.108
	(0.297)	(0.325)	(0.506)	(0.905)	(1.238)	(0.515)	(0.451)
PubInsClaim*Insurable Shock		-0.385	0.361	-1.930	-0.841	-0.454	-0.872
		(0.745)	(1.414)	(1.859)	(2.118)	(1.268)	(0.958)
Transfers	0.252*	0.308**	0.426	-0.151	0.332	0.247	0.262
	(0.138)	(0.147)	(0.318)	(0.371)	(0.327)	(0.219)	(0.219)
Transfers*Insurable Shock		-0.480	-1.018	0.742	0.395	-0.769	-0.714
		(0.381)	(0.734)	(0.923)	(0.916)	(0.593)	(0.592)
Household Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	6,118	6,118	2,036	2,040	2,042	3,087	3,031
R-squared	0.035	0.035	0.059	0.058	0.029	0.040	0.045
Number of households	2,043	2,043	1,204	1,365	1,225	1,275	1,265

Robust standard errors are clustered at the household level and are given in parenthesis. *** indicates significance at the 1% level, ** indicates significance at the 5% level, * indicates significance at the 10% level.

Note: Households with no Crop Stores are automatically dropped from the estimation. We do not present results for the interaction between transfers and natural shocks as it is statistically insignificant in all cases.

2.6 Conclusion

In this paper, we examine the consequences of risk on households' ex post behavior by examining *both* consumption and savings responses to the incidence of adverse income shocks. We also consider the role of formal insurance and other social safety nets in the consumption insurance process. Our theoretical model predicts that in the presence of formal insurance markets households will insure against forms of idiosyncratic risk and precautionary save to protect against any uninsurable spatially covariant risk. We test the hypotheses proposed by our model ex post using a unique panel dataset of rural Vietnamese households for the period 2006 to 2010. Vietnam represents an interesting illustrative case study given the recent development of formal rural financial markets which has significantly increased access to formal financial products for rural households. Moreover, Vietnam is characterized by a very high incidence of adverse income shocks but also has in place a variety of government social safety nets that aim to protect the most vulnerable. This is the first empirical case study which has considered the ex post responses of households to negative income shocks where information on formal insurance, public safety nets and savings instruments is available.

We find that households in rural Vietnam do not manage to fully protect consumption in the face of adverse income shocks. Nevertheless, an important mechanism for consumption smoothing efforts across states of nature is the use of savings. Financial savings, particularly cash and gold held at home, act as an important buffer in the face of covariant natural shocks. Insurance markets play an important role in easing the depletion of financial savings and livestock holdings over time in response to idiosyncratic shocks but only free public insurance and not voluntarily purchased insurance. We also find some evidence that external transfers are important for risk-coping in the face of natural disasters for some households. Of particular note is the fact that borrowing is increased when households are faced with idiosyncratic and covariant shocks, particularly for the poorest households.

These findings provide evidence in support of the importance of risk-coping (in the form of savings depletion and free public insurance instruments) as underlying consumption protection mechanisms for rural Vietnamese households where income variability matters. Such savings, if originally intended for precautionary purposes may lead to lower welfare

outcomes in the long run given that they may result in lower levels of consumption and channel valuable capital resources away from more productive household uses. This is exacerbated by the fact that the uncertainty associated with income shocks may lead households to save excessively in these forms, conditional on their risk preferences. Furthermore, the requirement to draw down these assets in response to income shocks also has adverse consequences for household capital trajectories. While our results suggest that the presence of free public insurance instruments reduces the need to draw down savings, there is strong evidence to suggest that formal insurance markets, particularly voluntary insurance contracts, do not fully cover idiosyncratic risks. Future work is needed to investigate the interplay between consumption, investment and savings decisions by risk averse households in developing countries facing income uncertainty and inefficient formal insurance markets.

Appendix 2.1: Derivation of savings level A

2.1.1Model with no insurance

First order condition for savings A from equation (2):
$U'(W-A) = \beta(1+r)EU'(\tilde{\alpha}W - \tilde{\gamma} + A(1+r)])$

Rewriting and assuming $\beta(1+r) = 1$ and $r = 0$:
$U'(W-A) - EU'(\tilde{\alpha}W - \tilde{\gamma} + A) = 0$

Taking a second order Taylor expansion of $U'(W-A)$ and $EU'(\tilde{\alpha}W - \tilde{\gamma} + A)$ about W:

$$U'(W) - U''(W)A + \frac{1}{2}U'''(W)A^2 - E\left[U'(W) + U''(W)(W(\tilde{\alpha}-1) - \tilde{\gamma} + A) + \frac{1}{2}U'''(W)(W(\tilde{\alpha}-1) - \tilde{\gamma} + A)^2\right] = 0$$

Expanding the terms within the expectations operator:

$$U'(W) - U''(W)A + \frac{1}{2}U'''(W)A^2 - E\left[U'(W) + U''(W)W(\tilde{\alpha}-1) - U''(W)\tilde{\gamma} + U''(W)A + \frac{1}{2}U'''(W)W^2(\tilde{\alpha}-1)^2 - U'''(W)W(\tilde{\alpha}-1)\tilde{\gamma} + U'''(W)W(\tilde{\alpha}-1)A + \frac{1}{2}U'''(W)\tilde{\gamma}^2 + \frac{1}{2}U'''(W)A^2 - U'''(W)\tilde{\gamma}A\right] = 0$$

Recall $E(\tilde{\alpha}) = \alpha$ and $E(\tilde{\gamma}) = \gamma$ and note that

$$V(\tilde{\gamma}) = \sigma_\gamma^2 = E((\tilde{\gamma}-\gamma)^2) = E(\tilde{\gamma}^2) - \gamma^2$$
$$\gamma^2 + V(\tilde{\gamma}) = \gamma^2 + E(\tilde{\gamma}^2) - \gamma^2 = E(\tilde{\gamma}^2)$$

$$V(\tilde{\alpha}) = \sigma_\alpha^2 = E((\tilde{\alpha}-\alpha)^2) = E(\tilde{\alpha}^2) - \alpha^2$$
$$E((\tilde{\alpha}-1)^2) = E(\tilde{\alpha}^2 - 2\tilde{\alpha} + 1) = E(\tilde{\alpha}^2) - 2E(\tilde{\alpha}) + 1 = E(\tilde{\alpha}^2) - 2\alpha + 1$$
$$(\alpha-1)^2 + V(\tilde{\alpha}) = \alpha^2 - 2\alpha + 1 + E(\tilde{\alpha}^2) - \alpha^2 = E(\tilde{\alpha}^2) - 2\alpha + 1 = E((\tilde{\alpha}-1)^2)$$

Evaluating the expectation:

$$U'(W) - U''(W)A + \frac{1}{2}U'''(W)A^2 - U'(W) - U''(W)W(\alpha-1) + U''(W)\gamma - U''(W)A - \frac{1}{2}U'''(W)W^2((\alpha-1)^2 + \sigma_\alpha^2) + U'''(W)W(\alpha-1)\gamma - U'''(W)W(\alpha-1)A - \frac{1}{2}U'''(W)(\gamma^2 + \sigma_\gamma^2) - \frac{1}{2}U'''(W)A^2 + U'''(W)\gamma A = 0$$

Grouping the terms:

$$U''(W)[-2A - W(\alpha - 1) + \gamma] + U'''(W)\left[-\frac{1}{2}W^2((\alpha - 1)^2 + \sigma_\alpha^2) + W(\alpha - 1)\gamma - W(\alpha - 1)A - \frac{1}{2}(\gamma^2 + \sigma_\gamma^2) + \gamma A\right] = 0$$

Dividing across by $U'''(W)$:

$$\frac{U''(W)}{U'''(W)}[-2A - W(\alpha - 1) + \gamma] - \frac{1}{2}W^2((\alpha - 1)^2 + \sigma_\alpha^2) + W(\alpha - 1)\gamma - W(\alpha - 1)A - \frac{1}{2}(\gamma^2 + \sigma_\gamma^2) + \gamma A = 0$$

Substituting in the co-efficient of absolute prudence $\varphi = -\frac{U'''(.)}{U''(.)}$:

$$-\frac{1}{\varphi}[-2A - W(\alpha - 1) + \gamma] - \frac{1}{2}W^2((\alpha - 1)^2 + \sigma_\alpha^2) + W(\alpha - 1)\gamma - W(\alpha - 1)A - \frac{1}{2}(\gamma^2 + \sigma_\gamma^2) + \gamma A = 0$$

Grouping the terms for A on the left hand side and taking a common denominator of 2φ on right hand side:

$$A\left[\frac{2 - \varphi W(\alpha - 1) + \varphi\gamma}{\varphi}\right] = \frac{-2W(\alpha - 1) + \varphi W^2(\alpha - 1)^2 - 2\varphi W(\alpha - 1)\gamma + 2\gamma + \varphi\gamma^2 + \varphi W^2\sigma_\alpha^2 + \varphi\sigma_\gamma^2}{2\varphi}$$

Note: φ cancels on denominator in both sides.

Grouping first three terms, separating $-2\varphi W(\alpha - 1)\gamma$ and solving for A yields equation (3) in main text:

$$A = \frac{-W(\alpha - 1)[2 - \varphi W(\alpha - 1) + \varphi\gamma]}{2[2 - \varphi W(\alpha - 1) + \varphi\gamma]} + \frac{\gamma[2 - \varphi W(\alpha - 1) + \varphi\gamma]}{2[2 - \varphi W(\alpha - 1) + \varphi\gamma]} + \frac{\varphi W^2\sigma_\alpha^2}{4 - 2\varphi W(\alpha - 1) + 2\varphi\gamma} + \frac{\varphi\sigma_\gamma^2}{4 - 2\varphi W(\alpha - 1) + 2\varphi\gamma}$$

$$A = \frac{W(1 - \alpha) + \gamma}{2} + \frac{\varphi W^2\sigma_\alpha^2}{4 - 2\varphi W(\alpha - 1) + 2\varphi\gamma} + \frac{\varphi\sigma_\gamma^2}{4 - 2\varphi W(\alpha - 1) + 2\varphi\gamma}$$

2.1.2 Model with insurance and actuarially fair insurance pricing (loading factor $\theta = 1$)

First order condition for savings A from equation (6):
$U'(W - A - IE(\tilde{\gamma})) = \beta(1+r)EU'(\tilde{\alpha}W - \tilde{\gamma} + A(1+r) + I\tilde{\gamma})$

Rewriting and assuming $\beta(1+r) = 1$ and $r = 0$:
$U'\big(W - A - IE(\tilde{\gamma})\big) - EU'(\tilde{\alpha}W - \tilde{\gamma} + A + I\tilde{\gamma}) = 0$

Expanding within expectations operator (1)

$$U'(W) - U''(W)A - U''(W)I\gamma + \frac{1}{2}U'''(W)A^2 + U'''(W)AI\gamma + \frac{1}{2}U'''(W)I^2\gamma^2 - E\Big[U'(W) + U''(W)(W(\tilde{\alpha}-1) - \tilde{\gamma} + A + I\tilde{\gamma}) + \frac{1}{2}U'''(W)(W(\tilde{\alpha}-1) - \tilde{\gamma} + A + I\tilde{\gamma})^2\Big] = 0$$

Expanding within expectations operator (2)

$$U'(W) - U''(W)A - U''(W)I\gamma + \frac{1}{2}U'''(W)A^2 + U'''(W)AI\gamma + \frac{1}{2}U'''(W)I^2\gamma^2 - E\Big[U'(W) + U''(W)W(\tilde{\alpha}-1) - U''(W)\tilde{\gamma} + U''(W)A + U''(W)I\tilde{\gamma} + \frac{1}{2}U'''(W)(W(\tilde{\alpha}-1) - \tilde{\gamma} + A + I\tilde{\gamma})^2\Big] = 0$$

Expanding within expectations operator (3)

$$U'(W) - U''(W)A - U''(W)I\gamma + \frac{1}{2}U'''(W)A^2 + U'''(W)AI\gamma + \frac{1}{2}U'''(W)I^2\gamma^2 - E\Big[U'(W) + U''(W)W(\tilde{\alpha}-1) - U''(W)\tilde{\gamma} + U''(W)A + U''(W)I\tilde{\gamma} + \frac{1}{2}U'''(W) + \frac{1}{2}U'''(W)(W^2(\tilde{\alpha}-1)^2 - 2W(\tilde{\alpha}-1)\tilde{\gamma} + 2W(\tilde{\alpha}-1)A + 2W(\tilde{\alpha}-1)I\tilde{\gamma} + \tilde{\gamma}^2 - 2\tilde{\gamma}A - 2I\tilde{\gamma}^2 + 2AI\tilde{\gamma} + I^2\gamma^2 + A^2)\Big] = 0$$

Expanding within expectations operator(4)

$$U'(W) - U''(W)A - U''(W)I\gamma + \frac{1}{2}U'''(W)A^2 + U'''(W)AI\gamma + \frac{1}{2}U'''(W)I^2\gamma^2 - E\Big[U'(W) + U''(W)W(\tilde{\alpha}-1) - U''(W)\tilde{\gamma} + U''(W)A + U''(W)I\tilde{\gamma} + \frac{1}{2}U'''(W)W^2(\tilde{\alpha}-1)^2 - U'''(W)W(\tilde{\alpha}-1)\tilde{\gamma} + U'''(W)W(\tilde{\alpha}-1)A + U'''(W)W(\tilde{\alpha}-1)I\tilde{\gamma} + \frac{1}{2}U'''(W)\tilde{\gamma}^2 - U'''(W)\tilde{\gamma}A - U'''(W)I\tilde{\gamma}^2 + U'''(W)AI\tilde{\gamma} + \frac{1}{2}U'''(W)I^2\tilde{\gamma}^2 + \frac{1}{2}U'''(W)A^2)\Big] = 0$$

Applying expectations operator

$$U'(W) - U''(W)A - U''(W)I\gamma + \frac{1}{2}U'''(W)A^2 + U'''(W)AI\gamma + \frac{1}{2}U'''(W)I^2\gamma^2 - U'(W) - U''(W)W(\alpha - 1) + U''(W)\gamma - U''(W)A - U''(W)I\gamma - \frac{1}{2}U'''(W)W^2((\alpha - 1)^2 + \sigma_\alpha^2) + U'''(W)W(\alpha - 1)\gamma - U'''(W)W(\alpha - 1)A - U'''(W)W(\alpha - 1)I\gamma - \frac{1}{2}U'''(W)(\gamma^2 + \sigma_\gamma^2) + U'''(W)\gamma A + U'''(W)I(\gamma^2 + \sigma_\gamma^2) - U'''(W)AI\gamma - \frac{1}{2}U'''(W)I^2(\gamma^2 + \sigma_\gamma^2) - \frac{1}{2}U'''(W)A^2 = 0$$

Evaluating the expectations and simplifying where possible:

$$-2U''(W)A - 2U''(W)I\gamma - U''(W)W(\alpha - 1) + U''(W)\gamma - \frac{1}{2}U'''(W)W^2((\alpha - 1)^2 + \sigma_\alpha^2) + U'''(W)W(\alpha - 1)\gamma - U'''(W)W(\alpha - 1)A - U'''(W)W(\alpha - 1)I\gamma - \frac{1}{2}U'''(W)(\gamma^2 + \sigma_\gamma^2) + U'''(W)\gamma A + U'''(W)I(\gamma^2 + \sigma_\gamma^2) - \frac{1}{2}U'''(W)I^2\sigma_\gamma^2 = 0$$

Grouping the terms:

$$U''(W)[-2A - 2I\gamma - W(\alpha - 1) + \gamma] + U'''(W)[-\frac{1}{2}W^2((\alpha - 1)^2 + \sigma_\alpha^2) + W(\alpha - 1)\gamma - W(\alpha - 1)A - W(\alpha - 1)I\gamma - \frac{1}{2}(\gamma^2 + \sigma_\gamma^2) + \gamma A + I(\gamma^2 + \sigma_\gamma^2) - \frac{1}{2}I^2\sigma_\gamma^2] = 0$$

Dividing across by $U'''(W)$

$$\frac{U''(W)}{U'''(W)}[-2A - 2I\gamma - W(\alpha - 1) + \gamma] - \frac{1}{2}W^2((\alpha - 1)^2 + \sigma_\alpha^2) + W(\alpha - 1)\gamma - W(\alpha - 1)A - W(\alpha - 1)I\gamma - \frac{1}{2}(\gamma^2 + \sigma_\gamma^2) + \gamma A + I(\gamma^2 + \sigma_\gamma^2) - \frac{1}{2}I^2\sigma_\gamma^2 = 0$$

Substituting co-efficient of absolute prudence $\varphi = -\frac{U'''}{U''}$

$$-\frac{1}{\varphi}[-2A - 2I\gamma - W(\alpha - 1) + \gamma] - \frac{1}{2}W^2((\alpha - 1)^2 + \sigma_\alpha^2) + W(\alpha - 1)\gamma - W(\alpha - 1)A - W(\alpha - 1)I\gamma - \frac{1}{2}(\gamma^2 + \sigma_\gamma^2) + \gamma A + I(\gamma^2 + \sigma_\gamma^2) - \frac{1}{2}I^2\sigma_\gamma^2 = 0$$

Expanding terms within brackets

$$\frac{2A}{\varphi} + \frac{2I\gamma}{\varphi} + \frac{W(\alpha - 1)}{\varphi} - \frac{\gamma}{\varphi} - \frac{1}{2}W^2((\alpha - 1)^2 + \sigma_\alpha^2) + W(\alpha - 1)\gamma - W(\alpha - 1)A - W(\alpha - 1)I\gamma - \frac{1}{2}(\gamma^2 + \sigma_\gamma^2) + \gamma A + I(\gamma^2 + \sigma_\gamma^2) - \frac{1}{2}I^2\sigma_\gamma^2 = 0$$

Grouping terms of A on left hand side

$$\frac{2A}{\varphi} - W(\alpha-1)A + \gamma A$$
$$= -\frac{2I\gamma}{\varphi} - \frac{W(\alpha-1)}{\varphi} + \frac{\gamma}{\varphi} + \frac{1}{2}W^2((\alpha-1)^2 + \sigma_\alpha^2) - W(\alpha-1)\gamma$$
$$+ W(\alpha-1)I\gamma + \frac{1}{2}(\gamma^2 + \sigma_\gamma^2) - I(\gamma^2 + \sigma_\gamma^2) + \frac{1}{2}I^2\sigma_\gamma^2$$

Simplifying terms of A on left hand side

$$A\left[\frac{2 - \varphi W(\alpha-1) + \varphi\gamma}{\varphi}\right]$$
$$= -\frac{2I\gamma}{\varphi} - \frac{W(\alpha-1)}{\varphi} + \frac{\gamma}{\varphi} + \frac{1}{2}W^2((\alpha-1)^2 + \sigma_\alpha^2) - W(\alpha-1)\gamma$$
$$+ W(\alpha-1)I\gamma + \frac{1}{2}(\gamma^2 + \sigma_\gamma^2) - I(\gamma^2 + \sigma_\gamma^2) + \frac{1}{2}I^2\sigma_\gamma^2$$

Expanding terms on right hand side

$$A\left[\frac{2 - \varphi W(\alpha-1) + \varphi\gamma}{\varphi}\right]$$
$$= -\frac{2I\gamma}{\varphi} - \frac{W(\alpha-1)}{\varphi} + \frac{\gamma}{\varphi} + \frac{1}{2}W^2(\alpha-1)^2 + \frac{1}{2}W^2\sigma_\alpha^2 - W(\alpha-1)\gamma$$
$$+ W(\alpha-1)I\gamma + \frac{1}{2}\gamma^2 + \frac{1}{2}\sigma_\gamma^2 - I\gamma^2 - I\sigma_\gamma^2 + \frac{1}{2}I^2\sigma_\gamma^2$$

Expanding terms further on right hand side

$$A\left[\frac{2 - \varphi W(\alpha-1) + \varphi\gamma}{\varphi}\right]$$
$$= -\frac{2I\gamma}{\varphi} - \frac{W(\alpha-1)}{\varphi} + \frac{\gamma}{\varphi} + \frac{1}{2}W^2(\alpha-1)^2 + \frac{1}{2}W^2\sigma_\alpha^2 - W(\alpha-1)\gamma$$
$$+ W(\alpha-1)I\gamma + \frac{\gamma^2}{2}[1-2I] + \frac{\sigma_\gamma^2}{2}[1-2I+I^2]$$

Grouping on right hand side

$$A\left[\frac{2 - \varphi W(\alpha-1) + \varphi\gamma}{\varphi}\right]$$
$$= -\frac{2I\gamma}{\varphi} - \frac{W(\alpha-1)}{\varphi} + \frac{\gamma}{\varphi} + \frac{1}{2}W^2(\alpha-1)^2 - W(\alpha-1)\gamma + W(\alpha-1)I\gamma$$
$$+ \frac{\gamma^2}{2}[1-2I] + \frac{\sigma_\gamma^2}{2}(I-1)^2 + \frac{1}{2}W^2\sigma_\alpha^2$$

Grouping common terms on the right hand side

$$A\left[\frac{2 - \varphi W(\alpha-1) + \varphi\gamma}{\varphi}\right]$$
$$= -\frac{W(\alpha-1)}{2}\left[\frac{2 - \varphi W(\alpha-1) + \varphi\gamma}{\varphi}\right] + \frac{\gamma}{2}\left[\frac{2 - \varphi W(\alpha-1) + \varphi\gamma}{\varphi}\right]$$
$$- I\gamma\left[\frac{2 - \varphi W(\alpha-1) - \varphi\gamma}{\varphi}\right] + \frac{\sigma_\gamma^2}{2}(I-1)^2 + \frac{1}{2}W^2\sigma_\alpha^2$$

Isolating A

$$A \cong -\frac{W(\alpha-1)}{2}+\frac{\gamma}{2}-I\gamma+\frac{\varphi\sigma_{\gamma}^{2}(I-1)^{2}}{2[2-\varphi W(\alpha-1)+\varphi\gamma]}+\frac{\varphi W^{2}\sigma_{\alpha}^{2}}{2[2-\varphi W(\alpha-1)+\varphi\gamma]}$$

2.1.3 Model with insurance and variable loading factor ($\theta \geq 0$)

First order condition for savings A from equation (6):
$U'(W - A - I\theta E(\tilde{\gamma})) = \beta(1+r)EU'(\tilde{\alpha}W - \tilde{\gamma} + A(1+r) + I\tilde{\gamma})$

Rewriting and assuming $\beta(1+r) = 1$ and $r = 0$:
$U'(W - A - I\theta E(\tilde{\gamma})) - EU'(\tilde{\alpha}W - \tilde{\gamma} + A + I\tilde{\gamma}) = 0$

Taking a second order Taylor expansion of $U'(W - A - I\theta\gamma)$ and $EU'(\tilde{\alpha}W - \tilde{\gamma} + A + I\tilde{\gamma})$ about W:

$$U'(W) - U''(W)A - U''(W)I\theta\gamma + \frac{1}{2}U'''(W)A^2 + U'''(W)AI\theta\gamma + \frac{1}{2}U'''(W)I^2\theta^2\gamma^2$$
$$- E\left[U'(W) + U''(W)(W(\tilde{\alpha}-1) - \tilde{\gamma} + A + I\tilde{\gamma})\right.$$
$$\left. + \frac{1}{2}U'''(W)(W(\tilde{\alpha}-1) - \tilde{\gamma} + A + I\tilde{\gamma})^2\right] = 0$$

Expanding within expectations operator (1)

$$U'(W) - U''(W)A - U''(W)I\theta\gamma + \frac{1}{2}U'''(W)A^2 + U'''(W)AI\theta\gamma + \frac{1}{2}U'''(W)I^2\theta^2\gamma^2$$
$$- E\left[U'(W) + U''(W)W(\tilde{\alpha}-1) - U''(W)\tilde{\gamma} + U''(W)A + U''(W)I\tilde{\gamma}\right.$$
$$\left. + \frac{1}{2}U'''(W)(W(\tilde{\alpha}-1) - \tilde{\gamma} + A + I\tilde{\gamma})^2\right] = 0$$

Expanding within expectations operator (2)

$$U'(W) - U''(W)A - U''(W)I\theta\gamma + \frac{1}{2}U'''(W)A^2 + U'''(W)AI\theta\gamma + \frac{1}{2}U'''(W)I^2\theta^2\gamma^2$$
$$- E\left[U'(W) + U''(W)W(\tilde{\alpha}-1) - U''(W)\tilde{\gamma} + U''(W)A + U''(W)I\tilde{\gamma}\right.$$
$$+ \frac{1}{2}U'''(W) + \frac{1}{2}U'''(W)(W^2(\tilde{\alpha}-1)^2 - 2W(\tilde{\alpha}-1)\tilde{\gamma} + 2W(\tilde{\alpha}-1)A$$
$$\left. + 2W(\tilde{\alpha}-1)I\tilde{\gamma} + \tilde{\gamma}^2 - 2\tilde{\gamma}A - 2I\tilde{\gamma}^2 + 2AI\tilde{\gamma} + I^2\gamma^2 + A^2)\right] = 0$$

Expanding within expectations operator (3)

$$U'(W) - U''(W)A - U''(W)I\theta\gamma + \frac{1}{2}U'''(W)A^2 + U'''(W)AI\theta\gamma + \frac{1}{2}U'''(W)I^2\theta^2\gamma^2$$
$$- E\left[U'(W) + U''(W)W(\tilde{\alpha}-1) - U''(W)\tilde{\gamma} + U''(W)A + U''(W)I\tilde{\gamma}\right.$$
$$+ \frac{1}{2}U'''(W)W^2(\tilde{\alpha}-1)^2 - U'''(W)W(\tilde{\alpha}-1)\tilde{\gamma} + U'''(W)W(\tilde{\alpha}-1)A$$
$$+ U'''(W)W(\tilde{\alpha}-1)I\tilde{\gamma} + \frac{1}{2}U'''(W)\tilde{\gamma}^2 - U'''(W)\tilde{\gamma}A - U'''(W)I\tilde{\gamma}^2$$
$$\left. + U'''(W)AI\tilde{\gamma} + \frac{1}{2}U'''(W)I^2\tilde{\gamma}^2 + \frac{1}{2}U'''(W)A^2)\right] = 0$$

Applying expectations operator (4)

$$U'(W) - U''(W)A - U''(W)I\theta\gamma + \frac{1}{2}U'''(W)A^2 + U'''(W)AI\theta\gamma + \frac{1}{2}U'''(W)I^2\theta^2\gamma^2 - U'(W) - U''(W)W(\alpha - 1) + U''(W)\gamma - U''(W)A - U''(W)I\gamma - \frac{1}{2}U'''(W)W^2((\alpha - 1)^2 + \sigma_\alpha^2) + U'''(W)W(\alpha - 1)\gamma - U'''(W)W(\alpha - 1)A - U'''(W)W(\alpha - 1)I\gamma - \frac{1}{2}U'''(W)(\gamma^2 + \sigma_\gamma^2) + U'''(W)\gamma A + U'''(W)I(\gamma^2 + \sigma_\gamma^2) - U'''(W)AI\gamma - \frac{1}{2}U'''(W)I^2(\gamma^2 + \sigma_\gamma^2) - \frac{1}{2}U'''(W)A^2 = 0$$

Evaluating the expectations and simplifying where possible:

$$-2U''(W)A - U''(W)I\gamma(\theta + 1) - U''(W)W(\alpha - 1) + U''(W)\gamma - \frac{1}{2}U'''(W)W^2((\alpha - 1)^2 + \sigma_\alpha^2) + U'''(W)W(\alpha - 1)\gamma - U'''(W)W(\alpha - 1)A - U'''(W)W(\alpha - 1)I\gamma - \frac{1}{2}U'''(W)(\gamma^2 + \sigma_\gamma^2) + U'''(W)\gamma A + U'''(W)I(\gamma^2 + \sigma_\gamma^2) + U'''(W)AI\gamma(\theta - 1) + \frac{1}{2}U'''(W)I^2\gamma^2(\theta^2 - 1) - \frac{1}{2}U'''(W)I^2\sigma_\gamma^2 = 0$$

Grouping the terms:

$$U''(W)[-2A - I\gamma(\theta + 1) - W(\alpha - 1) + \gamma] + U'''(W)[-\frac{1}{2}W^2((\alpha - 1)^2 + \sigma_\alpha^2) + W(\alpha - 1)\gamma - W(\alpha - 1)A - W(\alpha - 1)I\gamma - \frac{1}{2}(\gamma^2 + \sigma_\gamma^2) + \gamma A + I(\gamma^2 + \sigma_\gamma^2) + AI\gamma(\theta - 1) + \frac{1}{2}I^2\gamma^2(\theta^2 - 1) - \frac{1}{2}I^2\sigma_\gamma^2] = 0$$

Dividing across by $U'''(W)$:

$$\frac{U''(W)}{U'''(W)}[-2A - (\theta + 1)I\gamma - W(\alpha - 1) + \gamma] - \frac{1}{2}W^2((\alpha - 1)^2 + \sigma_\alpha^2) + W(\alpha - 1)\gamma - W(\alpha - 1)A - W(\alpha - 1)I\gamma - \frac{1}{2}(\gamma^2 + \sigma_\gamma^2) + \gamma A + I(\gamma^2 + \sigma_\gamma^2) + AI\gamma(\theta - 1) + \frac{1}{2}I^2\gamma^2(\theta^2 - 1) - \frac{1}{2}I^2\sigma_\gamma^2 = 0$$

Substituting prudence:

$$-\frac{1}{\varphi}[-2A - (\theta + 1)I\gamma - W(\alpha - 1) + \gamma] - \frac{1}{2}W^2((\alpha - 1)^2 + \sigma_\alpha^2) + W(\alpha - 1)\gamma - W(\alpha - 1)A - W(\alpha - 1)I\gamma - \frac{1}{2}(\gamma^2 + \sigma_\gamma^2) + \gamma A + I(\gamma^2 + \sigma_\gamma^2) + AI\gamma(\theta - 1) + \frac{1}{2}I^2\gamma^2(\theta^2 - 1) - \frac{1}{2}I^2\sigma_\gamma^2 = 0$$

Expanding:

$$\frac{2A}{\varphi}+\frac{(\theta+1)I\gamma}{\varphi}+\frac{W(\alpha-1)}{\varphi}-\frac{\gamma}{\varphi}-\frac{1}{2}W^2((\alpha-1)^2+\sigma_\alpha^2)+W(\alpha-1)\gamma-W(\alpha-1)A$$
$$-W(\alpha-1)I\gamma-\frac{1}{2}(\gamma^2+\sigma_\gamma^2)+\gamma A+I(\gamma^2+\sigma_\gamma^2)+AI\gamma(\theta-1)$$
$$+\frac{1}{2}I^2\gamma^2(\theta^2-1)-\frac{1}{2}I^2\sigma_\gamma^2=0$$

Grouping terms of A on left hand side:

$$\frac{2A}{\varphi}-W(\alpha-1)A+\gamma A+AI\gamma(\theta-1)$$
$$=-\frac{(\theta+1)I\gamma}{\varphi}-\frac{W(\alpha-1)}{\varphi}+\frac{\gamma}{\varphi}+\frac{1}{2}W^2((\alpha-1)^2+\sigma_\alpha^2)-W(\alpha-1)\gamma$$
$$+W(\alpha-1)I\gamma+\frac{1}{2}(\gamma^2+\sigma_\gamma^2)-I(\gamma^2+\sigma_\gamma^2)-\frac{1}{2}I^2\gamma^2(\theta^2-1)+\frac{1}{2}I^2\sigma_\gamma^2$$

Simplifying terms of A on left hand side:

$$A\left[\frac{2-\varphi W(\alpha-1)+\varphi\gamma+\varphi I\gamma(\theta-1)}{\varphi}\right]$$
$$=-\frac{(\theta+1)I\gamma}{\varphi}-\frac{W(\alpha-1)}{\varphi}+\frac{\gamma}{\varphi}+\frac{1}{2}W^2((\alpha-1)^2+\sigma_\alpha^2)-W(\alpha-1)\gamma$$
$$+W(\alpha-1)I\gamma+\frac{1}{2}(\gamma^2+\sigma_\gamma^2)-I(\gamma^2+\sigma_\gamma^2)-\frac{1}{2}I^2\gamma^2(\theta^2-1)+\frac{1}{2}I^2\sigma_\gamma^2$$

Expanding terms on right hand side:

$$A\left[\frac{2-\varphi W(\alpha-1)+\varphi\gamma+\varphi I\gamma(\theta-1)}{\varphi}\right]$$
$$=-\frac{(\theta+1)I\gamma}{\varphi}-\frac{W(\alpha-1)}{\varphi}+\frac{\gamma}{\varphi}+\frac{1}{2}W^2(\alpha-1)^2+\frac{1}{2}W^2\sigma_\alpha^2-W(\alpha-1)\gamma$$
$$+W(\alpha-1)I\gamma+\frac{1}{2}\gamma^2+\frac{1}{2}\sigma_\gamma^2-I\gamma^2-I\sigma_\gamma^2-\frac{1}{2}I^2\gamma^2(\theta^2-1)+\frac{1}{2}I^2\sigma_\gamma^2$$

Expanding terms further on right hand side:

$$A\left[\frac{2-\varphi W(\alpha-1)+\varphi\gamma+\varphi I\gamma(\theta-1)}{\varphi}\right]$$
$$=-\frac{(\theta+1)I\gamma}{\varphi}-\frac{W(\alpha-1)}{\varphi}+\frac{\gamma}{\varphi}+\frac{1}{2}W^2(\alpha-1)^2+\frac{1}{2}W^2\sigma_\alpha^2-W(\alpha-1)\gamma$$
$$+W(\alpha-1)I\gamma+\frac{\gamma^2}{2}[1-2I]+\frac{\sigma_\gamma^2}{2}[1-2I+I^2]-\frac{1}{2}I^2\gamma^2(\theta^2-1)$$

Grouping on right hand side:

$$A\left[\frac{2-\varphi W(\alpha-1)+\varphi\gamma+\varphi I\gamma(\theta-1)}{\varphi}\right]$$
$$=-\frac{(\theta+1)I\gamma}{\varphi}-\frac{W(\alpha-1)}{\varphi}+\frac{\gamma}{\varphi}+\frac{1}{2}W^2(\alpha-1)^2-W(\alpha-1)\gamma$$
$$+W(\alpha-1)I\gamma+\frac{\gamma^2}{2}[1-2I]-\frac{1}{2}I^2\gamma^2(\theta^2-1)+\frac{\sigma_\gamma^2}{2}(I-1)^2+\frac{1}{2}W^2\sigma_\alpha^2$$

Grouping common terms on the right hand side:

$$A\left[\frac{2-\varphi W(\alpha-1)+\varphi\gamma(1+I(\theta-1))}{\varphi}\right]$$
$$=-\frac{W(\alpha-1)}{2}\left[\frac{2-\varphi W(\alpha-1)+\varphi\gamma(1+(I(\theta-1))}{\varphi}\right]$$
$$+\frac{\gamma}{2}\left[\frac{2-\varphi W(\alpha-1)+\varphi\gamma(1+I(\theta-1))}{\varphi}\right]$$
$$-I\gamma\left[\frac{(\theta+1)-\varphi W(\alpha-1)((\theta+1)/2)+\varphi\gamma((\theta+1)/2)+I(\theta-1))}{\varphi}\right]$$
$$+I^2\gamma^2\left[\frac{2\theta-1-\theta^2}{2}\right]+\frac{\sigma_\gamma^2}{2}(I-1)^2+\frac{1}{2}W^2\sigma_\alpha^2$$

Isolating A:

$$A\cong-\frac{W(\alpha-1)}{2}+\frac{\gamma}{2}$$
$$-I\gamma[\frac{(\theta+1)-\varphi W(\alpha-1)((\theta+1)/2)+\varphi\gamma((\theta+1)/2)+I(\theta-1))}{2-\varphi W(\alpha-1)+\varphi\gamma(1+(I(\theta-1))}$$
$$+\frac{\varphi I^2\gamma^2[2\theta-1-\theta^2]}{2[2-\varphi W(\alpha-1)+\varphi\gamma(1+I(\theta-1))]}$$
$$+\frac{\varphi\sigma_\gamma^2(I-1)^2}{2[2-\varphi W(\alpha-1)+\varphi\gamma(1+I(\theta-1))]}$$
$$+\frac{\varphi W^2\sigma_\alpha^2}{2[2-\varphi W(\alpha-1)+\varphi\gamma(1+I(\theta-1))]}$$

Appendix 2.2: Additional Tables

Appendix Table 2.2.1: Household Shocks and Recovery across Young and Old

	2006		*2008*		*2010*	
	Young	Old	Young	Old	Young	Old
Shock	43%	40%	59%	52%	56%	45%
Recovered	59%	62%	44%	24%	51%	24%

Note: Old is defined as any household head over the age of 31.5 (50^{th} percentile)

Appendix Table 2.2.2: Consumption Smoothing Tests 2008 (across states of nature)

	Dependent Variable Household Food Consumption Growth			
Independent Variables	Full Sample	Lowest Wealth Group	Middle Wealth Group	Highest Wealth Group
	(1)	(2)	(3)	(4)
Shock Persistence	-0.077	-0.058	-0.138	-0.015
	(0.050)	(0.116)	(0.119)	(0.096)
Exogenous: Natural	0.093	0.059	0.198**	0.058
Shocks	(0.058)	(0.116)	(0.097)	(0.105)
Exogenous: Economic	0.231**	0.264*	0.072	0.378***
Shocks	(0.088)	(0.148)	(0.187)	(0.137)
Idiosyncratic: Insurable	0.016	0.070	-0.339**	0.253**
Shocks	(0.074)	(0.129)	(0.143)	(0.112)
Idiosyncratic:	0.038	-0.051	0.238	0.021
Uninsurable Shock	(0.095)	(0.265)	(0.195)	(0.139)
Income Growth	0.078***	-0.150**	-0.097	-0.036
	(0.032)	(0.060)	(0.060)	(0.046)
Growth in HH Size	0.017	0.219	-0.081	-0.013
	(0.087)	(0.139)	(0.136)	(0.172)
Wealth Group	Yes			
District Controls	Yes	Yes	Yes	Yes
Constant	0.654***	0.462***	0.945***	-0.570***
	(0.069)	(0.173)	(0.124)	(0.189)
Observations	2027	673	676	678
R-squared	0.235	0.309	0.329	0.290

Robust standard errors clustered at the district level are given in parenthesis. *** indicates significance at the 1% level, ** indicates significance at the 5% level, * indicates significance at the 10% level.

Appendix Table 2.2.3: Fixed effects estimates of the impact of income shocks on Formal Savings

Independent Variables	***Dependent Variable Household Levels of Formal Savings***				
	(1) Full sample	*(2) Full sample*	*(3) Wealth Group 3*	*(4) Young*	*(5) Old*
Exogenous: Natural Shock	-0.230	-0.214	0.284	-0.007	-0.040
	(0.314)	(0.327)	(0.353)	(0.649)	(0.356)
Exogenous: Economic Shock	-0.234	-0.156	-0.472	0.467	-0.896**
	(0.389)	(0.375)	(0.389)	(1.161)	(0.442)
Idiosyncratic: Insurable Shock	-0.501	-0.508	1.194**	0.018	0.298
	(0.333)	(0.409)	(0.506)	(1.315)	(0.415)
Idiosyncratic: Uninsurable Shock	0.469	0.376	0.378	0.000	0.295
	(0.393)	(0.422)	(0.574)	(0.000)	(0.382)
Voluntary Insurance Claim	-0.295	-0.285	0.724	0.000	-0.644*
	(0.485)	(0.463)	(0.663)	(0.000)	(0.371)
VolInsClaim* Insurable Shock		0.000	0.000	0.000	0.000
		(0.000)	(0.000)	(0.000)	(0.000)
Public Insurance Claim	-1.032*	-1.571***	0.000	0.000	-0.706
	(0.580)	(0.552)	(0.000)	(0.000)	(0.507)
PubInsClaim*Insurable Shock		1.745	0.000	0.000	1.070
		(1.200)	(0.000)	(0.000)	(1.060)
Transfers	0.558**	0.582**	0.523	-0.241	0.852***
	(0.220)	(0.253)	(0.324)	(0.367)	(0.278)
Transfers*Insurable Shock		-0.131	-0.858	0.000	-1.145**
		(0.530)	(0.689)	(0.000)	(0.555)
Household Controls	Yes	Yes	Yes	Yes	Yes
Time Dummies	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes
Number of observations	426	426	287	151	275
R-squared	0.280	0.304	0.367	0.478	0.353
Number of households	342	342	244	134	222

Robust standard errors are clustered at the household level and are given in parenthesis. *** indicates significance at the 1% level, ** indicates significance at the 5% level, * indicates significance at the 10% level.

Note: We do not present results for the interaction between transfers and natural shocks as it is statistically insignificant in all cases. There are insufficient observations for Wealth groups 2 and 3.

Appendix Table 2.2.4: Fixed effects estimates of the impact of income shocks on Informal Savings

Independent Variables	***Dependent Variable Household Levels of Informal Savings***					
	(1) Full sample	*(2) Full sample*	*(3) Wealth Group 2*	*(4) Wealth Group 3*	*(5) Young*	*(6) Old*
Exogenous: Natural Shock	0.180	0.136	-0.329	1.743*	0.074	0.757*
	(0.301)	(0.291)	(1.385)	(1.021)	(0.495)	(0.456)
Exogenous: Economic Shock	-0.765*	-0.716	0.000	-0.789	-0.839	0.541
	(0.459)	(0.476)	(0.000)	(1.180)	(0.766)	(0.553)
Idiosyncratic: Insurable Shock	-0.552	-0.791	-0.273	-1.634	-2.250	0.115
	(0.416)	(1.096)	(1.704)	(1.482)	(2.017)	(0.365)
Idiosyncratic: Uninsurable Shock	-0.770	-0.763	-1.485	1.230	-0.234	-2.263***
	(0.492)	(0.512)	(1.617)	(1.336)	(0.753)	(0.526)
Voluntary Insurance Claim	0.277	0.328	0.753	-0.539	0.839**	-0.130
	(0.330)	(0.360)	(3.486)	(1.048)	(0.426)	(0.746)
VolInsClaim* Insurable Shock		-0.183	0.000	1.056	0.401	0.820
		(0.944)	(0.000)	(1.281)	(0.998)	(1.339)
Public Insurance Claim	-0.445	-0.461	-1.181	-1.842*	-1.108***	0.276
	(0.463)	(0.461)	(2.286)	(1.020)	(0.397)	(0.416)
PubInsClaim*Insurable Shock		1.862***	0.000	2.118*	0.000	0.412
		(0.464)	(0.000)	(1.100)	(0.000)	(0.686)
Transfers	0.192	0.175	1.102	0.536	0.270	-0.004
	(0.257)	(0.232)	(1.220)	(0.536)	(0.341)	(0.398)
Transfers*Insurable Shock		0.279	-1.215	1.739	1.219	-0.004
		(1.209)	(3.266)	(1.533)	(2.346)	(0.791)
Household Controls	Yes	Yes	Yes	Yes	Yes	Yes
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	703	703	219	362	380	323
R-squared	0.205	0.214	0.823	0.510	0.390	0.343
Number of households	567	567	202	317	305	281

Robust standard errors are clustered at the household level and are given in parenthesis. *** indicates significance at the 1% level, ** indicates significance at the 5% level, * indicates significance at the 10% level.

Note: We do not present results for the interaction between transfers and natural shocks as it is statistically insignificant in all cases. There are insufficient observations for Wealth group 1.

Appendix Table 2.2.5: Fixed effects estimates of the impact of income shocks on Formal Borrowing

Independent Variables	***Dependent Variable Household Levels of Formal Borrowing***						
	(1) Full sample	*(2) Full sample*	*(3) Wealth Group 1*	*(4) Wealth Group 2*	*(5) Wealth Group 3*	*(6) Young*	*(7) Old*
Exogenous: Natural Shock	0.254	0.257	0.171	-0.015	0.151	0.053	0.429*
	(0.157)	(0.157)	(0.286)	(0.370)	(0.442)	(0.229)	(0.244)
Exogenous: Economic Shock	-0.179	-0.184	-0.826	-1.455**	0.866	-0.350	0.113
	(0.305)	(0.305)	(0.674)	(0.616)	(0.901)	(0.442)	(0.451)
Idiosyncratic: Insurable Shock	0.211	0.712**	1.497***	0.925	-0.656	0.686	0.585
	(0.185)	(0.308)	(0.572)	(0.652)	(0.841)	(0.463)	(0.474)
Idiosyncratic: Uninsurable Shock	-0.206	-0.246	-0.095	1.380*	-0.068	-0.542	0.049
	(0.325)	(0.323)	(0.870)	(0.726)	(0.704)	(0.485)	(0.468)
Voluntary Insurance Claim	-0.423	-0.556	-0.893	-0.869	-0.460	-0.272	-0.534
	(0.318)	(0.384)	(0.709)	(1.032)	(0.700)	(0.605)	(0.549)
VolInsClaim* Insurable Shock		0.580	0.469	2.120	3.382*	-1.641*	1.672*
		(0.676)	(1.253)	(1.856)	(2.029)	(0.995)	(0.926)
Public Insurance Claim	0.215	0.222	-0.052	0.070	0.901	0.196	0.196
	(0.265)	(0.285)	(0.457)	(0.767)	(0.981)	(0.464)	(0.383)
PubInsClaim*Insurable Shock		0.052	-0.474	-3.493***	0.823	0.719	-0.690
		(0.713)	(1.177)	(1.341)	(2.088)	(1.396)	(0.842)
Transfers	-0.053	0.040	-0.125	-0.404	0.453	0.056	0.429*
	(0.129)	(0.137)	(0.290)	(0.358)	(0.309)	(0.202)	(0.244)
Transfers*Insurable Shock		-0.790**	-1.310**	0.022	-0.300	-0.723	0.113
		(0.352)	(0.630)	(0.896)	(0.971)	(0.571)	(0.451)
Household Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	6,118	6,118	2,036	2,040	2,042	3,087	3,031
R-squared	0.020	0.021	0.040	0.069	0.020	0.031	0.025
Number of households	2,043	2,043	1,204	1,365	1,225	1,275	1,265

Robust standard errors are clustered at the household level and are given in parenthesis. *** indicates significance at the 1% level, ** indicates significance at the 5% level, * indicates significance at the 10% level.

Note: We do not present results for the interaction between transfers and natural shocks as it is statistically insignificant in all cases.

Appendix Table 2.2.6: Fixed effects estimates of the impact of income shocks on Informal Borrowing

Independent Variables	***Dependent Variable Household Levels of Informal Borrowing***						
	(1) Full sample	*(2) Full sample*	*(3) Wealth Group 1*	*(4) Wealth Group 2*	*(5) Wealth Group 3*	*(6) Young*	*(7) Old*
Exogenous: Natural Shock	0.535***	0.530***	1.363***	-0.012	-0.133	0.629***	0.582***
	(0.143)	(0.143)	(0.300)	(0.314)	(0.389)	(0.219)	(0.208)
Exogenous: Economic Shock	1.378***	1.377***	1.464**	2.157***	-0.895	1.893***	0.792*
	(0.305)	(0.305)	(0.635)	(0.709)	(0.766)	(0.444)	(0.453)
Idiosyncratic: Insurable Shock	0.978***	0.857***	0.565	0.364	0.921	0.987**	1.191***
	(0.178)	(0.313)	(0.621)	(0.757)	(0.711)	(0.478)	(0.461)
Idiosyncratic: Uninsurable Shock	1.062***	1.063***	0.166	0.931	1.171**	1.111**	0.770*
	(0.303)	(0.303)	(0.811)	(0.662)	(0.523)	(0.434)	(0.464)
Voluntary Insurance Claim	0.402	0.207	-0.632	0.284	-0.208	0.345	-0.125
	(0.299)	(0.333)	(0.826)	(0.787)	(0.556)	(0.660)	(0.413)
VolInsClaim* Insurable Shock		0.783	0.180	5.423***	-1.196	1.218	0.217
		(0.697)	(1.410)	(1.953)	(1.142)	(1.282)	(0.874)
Public Insurance Claim	0.419*	0.531**	-0.159	0.238	0.723	1.215***	-0.210
	(0.235)	(0.259)	(0.359)	(0.675)	(0.951)	(0.414)	(0.343)
PubInsClaim*Insurable Shock		-0.637	0.381	1.021	-2.666**	-1.343	-0.279
		(0.587)	(1.077)	(1.449)	(1.291)	(0.943)	(0.774)
Transfers	0.373***	0.358***	0.794***	0.418	0.086	0.329*	0.210
	(0.118)	(0.122)	(0.258)	(0.284)	(0.260)	(0.195)	(0.169)
Transfers*Insurable Shock		0.159	-0.236	1.170	-0.134	0.035	-0.411
		(0.368)	(0.713)	(0.897)	(0.848)	(0.577)	(0.552)
Household Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	6,118	6,118	2,036	2,040	2,042	3,087	3,031
R-squared	0.036	0.037	0.080	0.084	0.040	0.045	0.047
Number of households	2,043	2,043	1,204	1,365	1,225	1,275	1,265

Robust standard errors are clustered at the household level and are given in parenthesis. *** indicates significance at the 1% level, ** indicates significance at the 5% level, * indicates significance at the 10% level.

Note: We do not present results for the interaction between transfers and natural shocks as it is statistically insignificant in all cases.

Chapter 3:

Risk and Household Investment Decisions: Evidence from rural Vietnam

3.0 Abstract

This paper investigates the effect of risk on household investment and savings behaviour. We examine the extent to which exposure to exogenous covariant natural risk discourages households from investing in risky production activities while encouraging investment diversification across non-farm and liquid assets. We also evaluate the impact of ex ante risk-induced investments on profitability. Using panel data from rural Vietnam we find that covariant natural risk acts as a deterrent to household investment in own-farm capital while encouraging non-farm investment diversification in durable goods and savings in forms of non-productive liquid capital. Further, we find own-farm investment to be below profit maximizing levels. Our findings apply to the poorest, most credit constrained households which indicates that risk induces overall income-reducing behaviour for the vulnerable.

3.1 Introduction

It is well established that farming households in developing countries face a high probability of income loss due to shocks such as weather related events or livestock disease. The ability of households to adapt to the prevalence of income risks is an important determinant of welfare. Risk mitigation strategies are particularly difficult when credit and insurance markets are not well developed. In such cases, households are forced to rely on ex ante income smoothing measures such as diversifying their economic activities (Walker and Ryan, 1990; Kurosaki, 1995, Alderman and Paxon, 1992) or consumption smoothing measures such as precautionary saving in the form of liquid assets (Zeldes, 1989; Kimball, 1990; Deaton, 1991, 1992; Udry, 1994). Income diversification by risk averse households usually involves the substitution of higher levels of risky income for lower levels of secure income and so can have negative welfare consequences by reducing efficiency and profitability (Awudu and CroleRees, 2001; Ellis, 2000). Similarly, precautionary saving diverts household resources from productive activities (Wainwright and Newman, 2011).

Fafchamps (2010), in his authoritative overview of household risk management in developing country contexts, highlights that in spite of many theoretical contributions, there continues to

be a lack of empirical evidence on the link between exposure to risk and agricultural outcomes. We respond to his call for more work on uncovering this link in the case of Vietnam. In doing so we are fortunate to have access to a rich household panel dataset covering the period 2006 to 2010. Specifically, we investigate the impact of income risk on households' ex ante investment and savings decisions and, consequently, ex post profitability. This allows us to address whether income risk acts as a deterrent to risky, yet more profitable, own-farm investment by inducing diversification in less risky, less profitable, non-farm activities. As stressed by Fafchamps (2010) these are critical issues for policy makers concerned with furthering rural development and poverty reduction.

Our point of departure is that households employ a *mix* of risk reducing strategies that combine ex ante income diversification and saving with ex post consumption smoothing in the forms of saving depletion and borrowing. It follows that if households have the facility to smooth consumption through saving, then the amount of average income they are willing to forgo through diversification to avoid forms of income risk will be smaller. We therefore explore whether the presence of income risk increases household saving in liquid assets which may also indicate and underlying precautionary motive. We adopt a capital portfolio approach to overall household income risk reduction by considering capital investment diversification across own-farm activities and non-farm activities together with savings in liquid capital. This perspective has been little researched in the empirical literature. One seminal exception is Rosenzweig and Binswanger (1993) who find that farmers in riskier environments select portfolios of assets that are less sensitive to income risk and are also less profitable. We follow in their footsteps and provide an up to date case study on Vietnam also expanding the analysis to incorporate non-farm activities.

A key challenge is the identification of a measure of ex ante income risk facing households. We measure income risk using lagged realizations of natural shocks (weather related events and disease) recorded at the household level, which we term covariant risk in that they co-vary across households within regions.[57] Only risk that is not insurable will be reflected in ex

[57] Our 'experience based' risk proxy aligns with the psychological studies discussed by Cohen et al. (2008) which suggest that risk perception may be strongly influenced by the context individuals are in when they take their decisions. Here we model the context as corresponding to past experience (applicable for insurance decisions, as discussed in Kunreuther (1996) and in Browne and Hoyt (2000) and in stock market behaviour as discussed by Hirshleifer and Shumway (2003)). Our proxy also appeals to a behavioural motive behind household decision making where households are shown to be sensitive to whether they have recently been affected by similar events and can recall similar incidents (Fafchamps, 2010).

ante investment decisions (Rosenzweig and Binswanger, 1993). In Vietnam, natural risk in the form of flooding, drought, pest infestation or crop disease remains formally uninsurable and, due to the spatial nature of natural risks, informal insurance arrangements are also ineffective (Wainwright and Newman, 2011).[58]

Furthermore, a key focus is to identify whether any departures from total profit maximization can be directly attributed to forms of income risk. Fafchamps (2010) argues that there is little empirical evidence that risk aversion pulls agricultural households away from decisions that would, in time, make them more prosperous. In this paper we test this hypothesis for Vietnam.

Our results show that, consistent with theoretical predictions, risk, proxied by prior natural shocks, acts as a deterrent to own-farm capital investments and encourages ex ante diversification in non-farm non-productive capital investments and savings in the form of non-productive liquid assets. Our results apply to households in the lowest wealth group which lends support to the hypothesis that the poorest most credit constrained households are more likely to diversify their income streams as they are less willing, or able, to bear risk.

For ex post profit outcomes for the poorest households we show that they *over*-invest in both non-farm capital and liquid assets (for example, cash held at home and crop stores) relative to own-farm capital. Hence, aggregate own-farm investment is found to be below profit maximizing levels. Taken together, our results show that poor households in Vietnam favour diversification into less risky non-farm investment and liquid savings over more risky own-farm investment. Hence, we conclude that poorer households appear willing to forgo higher profit in favour of smoother income and consumption. As such we establish in practice, at least for the case of Vietnam, that risk induces income reducing behaviour.

The paper is organized as follows. In Section 3.2 we present a simple theoretical model to illustrate the capital allocation decisions of households across own-farm activities, non-farm activities and liquid assets in the presence of uninsured natural covariant risk. Section 3.3

[58] Although the primary focus of this study concerns the impact of covariate risk on household investment decisions, we control for other forms of household idiosyncratic risk in our empirical analysis. We postulate that covariate risk is more important for household farming investment decisions as it is not possible to insure against – either individually or collectively. It is possible to insure against idiosyncratic risk (either individually via formal insurance markets or collectively via informal risk-sharing arrangements).

develops the empirical specification resulting from the theoretical predictions. Section 3.4 describes the data and the main variables of interest. Section 3.5 presents the empirical results and Section 3.6 concludes.

3.2 Conceptual Framework

Adapting the approaches presented by Fafchamps (2010) and Fafchamps and Kurosaki (2002), we develop a simple two-period allocation model to understand the investment and savings decisions made by rural households (in developing country contexts) in the presence of covariant risk.[59,60] We assume for simplicity that the initial household accumulated total stock of wealth W_1 is augmented to include current period income through an aggregate income generating process where:

$$W_1 = A_0 + \theta_a \pi_1(A_0) + K_0 + \theta_k \pi_1(K_0) + H_0 + \theta_h \pi_1(H_0) \qquad (1)$$

A_0 is the household's initial endowment of liquid asset wealth (for example, formal and informal savings and cash/gold held at home); K_0 represents the initial endowment of own-farm agricultural assets net of current period depreciation (for example, irrigation investment, livestock, farm equipment and machinery); H_0 represents the initial endowment of non-farm assets net of current period depreciation (for example, home durable goods); $\theta_k \pi_1(K_0)$ and $\theta_h \pi_1(H_0)$ represent current period realized profits derived from own-farm and non-farm activities respectively; and $\theta_a \pi_1(A_0)$ represents the household realized returns to liquid saving. Hence, the random variables, θ_k, θ_h and θ_a represent realized own-farm covariant risk, non-farm realized risk and realized risk to liquid saving.[61] The household has a thrice differentiable state independent utility function, U, where $U'(.) > 0$, $U''(.) < 0$. and

[59] Specifically, we follow Fafchamps' (2010) modern treatment of Sandmo (1971) and extend the model to capture the effect of risk on a typical rural household's portfolio of investments – namely risky own- farm investments, less risky non-farm investments and less risky savings in liquid assets. For the purposes of this theoretical exposition (and in line with Rosenzweig and Binswanger (1993)) we treat returns to all activities as being derived from the profit function.

[60] This conceptual framework appeals to the simplicity and tractability of a two-period model framework. This simplicity allows inter-temporal decisions to be modelled whereby the first period represents the current period (or today) while the second period represents the future (or tomorrow). This simple interpretation also facilitates a panel empirical analysis where lifecycle savings and investment behaviour are explicitly considered.

[61] For the purposes of this theoretical exposition, we treat the covariant risk associated with own-farm activities ($\tilde{\theta}_k$), the risk associated with non-farm activities ($\tilde{\theta}_h$) and the risk associated with savings activities ($\tilde{\theta}_a$) as distinct random variables. Empirically, we observe own-farm related natural shocks and as such, we are primarily interested in the impact of prior realizations of these shocks (our risk proxy) on ex ante household investment and savings behaviour. Further, we assume (for ease of theoretical exposition) that covariant shocks to own-farm profits do not significantly impact the marginal product of own-farm capital.

$U'''(.) > 0$. The household is thus assumed to have a precautionary motive for saving (Kimball, 1990).[62]

Time is divided into two discrete intervals; in period one all current profits (from initial endowments) are realised and aggregated together to represent total wealth holdings W_1 as defined by equation (1) and from which household period one capital investment and savings (and hence consumption) decisions are made. At the beginning of period two, the household utilises current investment holdings (directly derived from period one capital allocation decisions) in own-farm assets K_1 and non-farm assets H_1 as capital inputs in selected own-farm and non-farm production activities respectively, while liquid assets A_1 are used to derive returns to liquid savings. During this final period all covariant own-farm related risk represented specifically by the random variable $\tilde{\theta}_k$, all categories of risk associated with non-farm activities $\tilde{\theta}_h$, all risk associated with savings activities $\tilde{\theta}_a$, together with associated profit returns $\pi_2(K_1)$ and $\pi_2(H_1)$ and savings returns $\pi_2(A_1)$, are realized. These returns together with the accumulated household stock of capital assets (net of depreciation) generate period two total wealth W_2 in a similar fashion to that given in equation (1) for W_1. For simplicity our model ends here although it is worth stating that within a full inter-temporal set-up the household would now proceed to allocate period two own-farm productive assets K_2 and non-farm assets H_2 together with forms of liquid savings A_2 which would act as inputs to period three profit activities and the cycle would then begin anew.

From own-farm activities the household obtains an expected period two profit return of $E[\tilde{\theta}_k]\pi_2(K_1)$ where $\tilde{\theta}_k$ is a random variable representing the multiplicative covariant natural risk specifically facing this activity with a mean $E[\tilde{\theta}_k] = 1$ and variance, σ_k^2. Similarly, expected period two profit returns to non-farm activities are represented as $E[\tilde{\theta}_h]\,\pi_2(H_1)$ where $\tilde{\theta}_h$ is the associated multiplicative risk specific to non-farm activities with a mean $E[\tilde{\theta}_k] = 1$ and variance, σ_h^2. Finally, expected returns to liquid savings are represented as $E[\tilde{\theta}_a]\,\pi_2(A_1)$ where $\tilde{\theta}_a$ is the associated multiplicative risk specific to formal and informal liquid savings activities with a mean $E[\tilde{\theta}_a] = 1$ and variance, σ_a^2. To characterise a typical rural developing country environment we impose that $\sigma_k^2 > \sigma_h^2 = \sigma_a^2$ with correlation coefficients, ρ_{kh}, ρ_{ka}, ρ_{ah}. Further, we assume that $\pi'(K) > \pi'(H) = \pi'(A)$. In other

[62] Although we do not explicitly model the precautionary component to the overall aggregate level of household investment and savings, we empirically consider that savings in liquid assets may have a precautionary motive.

words, investment in own-farm activities such as rice cultivation or livestock and aquaculture production is subject to greater risk and greater expected profit returns than investment in non-farm small enterprise activities such as hat weaving or garment-making (and savings in liquid capital). We also impose that profit returns to own-farm activities are imperfectly correlated with those of non-farm activities and liquid savings, which together with their different variances, provides an opportunity for household portfolio variance reduction through diversification across both types of productive activities and investment in liquid asset saving. We thus consider the following simple model of the household's inter-temporal optimization problem:

$$max_{A_1,K_1,H_1}\, U(W_1 - A_1 - K_1 - H_1) + \beta EU(A_1 + \tilde{\theta}_a \pi_2(A_1) + K_1 + \tilde{\theta}_k \pi_2(K_1) + H_1 + \tilde{\theta}_h \pi_2(H_2)) \quad (2)$$

where period one consumption $C_1 = W_1 - A_1 - K_1 - H_1$ and where the households residual period one stock of wealth (less consumption) is represented by $A_1 + K_1 + H_1$. We assume, as per Fafchamps (2010), that each household production activity has positive and decreasing marginal returns to K_1, H_1 and A_1, with marginal profit returns $\pi'(K_1) > 0$, $\pi'(H_1) > 0$, $\pi'(A_1) > 0$ and with $\pi''(K_1) < 0$, $\pi''(H_1) < 0$, $\pi''(A_1) < 0$. The First Order Conditions with respect to each control variable are derived as follows:

$$A_1 : -U'(.) + \beta E\left[U'(.)(1 + \tilde{\theta}_a \pi_2{}'(A_1))\right] = 0 \quad (3)$$

$$K_1 : -U'(.) + \beta \mathrm{E}[U'(.)(1 + \tilde{\theta}_k \pi_2{}'(K_1))] = 0 \quad (4)$$

$$H_1 : -U'(.) + \beta \mathrm{E}[U'(.)(1 + \tilde{\theta}_h \pi_2{}'(H_1))] = 0 \quad (5)$$

We first consider a scenario where the rural household is risk neutral (either induced by perfect capital markets or by intrinsic risk preferences). In this situation $U'(.)$ reduces to a constant. Furthermore, by explicitly assuming that the expected profit returns to own-farm production activities, $E[\tilde{\theta}_k]\pi_2{}'(K_1)$, are greater than those of non-farm activities, $E[\tilde{\theta}_h]\pi_2{}'(H_1)$, and returns to liquid asset holdings, $E[\tilde{\theta}_a]\pi_2{}'(A_1)$, the risk-neutral household will specialize in own-farm agricultural investment, K_1. Equation (3) is thus manipulated to yield:

$$(1 + E[\tilde{\theta}_k]\pi_2{}'(K_1)) = \frac{1}{\beta} \quad (6)$$

with

$$(1 + E[\tilde{\theta}_k]\pi_2{}'(K_1)) > (1 + E[\tilde{\theta}_h]\pi_2{}'(H_1)) = (1 + E[\tilde{\theta}_a]\pi_2{}'(A_1)) \quad (7)$$

Equation (6) states that in equilibrium, for a risk neutral household, the expected returns to investment in own-farm agricultural activities equals the inverse of the household's subjective discount rate. Investment decisions are thus independent of other household preferences, including preferences regarding risk. The household stands to gain from own-farm investment specialization as the expected marginal profit returns to investment in own-farm activities are greater than those of non-farm activities as illustrated by equation (7). Hence, the household portfolio allocation is that specific capital investment allocation that yields the maximum total household profit (hence maximum income) in this risk-neutral or full insurance scenario.

Under risk-aversion and in the absence of institutional arrangements for insuring covariant natural risk ex post, exposed rural households with insufficient wealth to act as an insurance buffer will select investment activities ex ante that reduce the variance of their incomes, even at the expense of higher returns – thereby providing a motive for investment diversification across risky own-farm activities, less risky non-farm activities and less risky savings conditional on risk preferences and asset variance/co-variances. Combining equations (4), (5) and (6) yields:

$$E[U'(.)\beta(1 + \tilde{\theta}_k\pi_2'(K_1))] = E[U'(.)\beta(1 + \tilde{\theta}_h\pi_2'(H_1))] = E[U'(.)\beta(1 + \tilde{\theta}_a\pi_2'(A_1))] = U'(.) \quad (8)$$

Equation (8) illustrates that in equilibrium the expected marginal utility gain to further investment in each asset class is equal whereby a risk-averse household will diversify investments across activities to equate period two expected marginal utilities (across own-farm investment K_1, non-farm investment H_1 and liquid asset savings, A_1) with current marginal utility. Hence, ex ante household investment decisions depend on full household preferences, including preferences regarding risk. A risk averse household will now allocate

investment capital across *both* own-farm activities and non-farm activities with resulting total profit reductions. Furthermore, the household will allocate a positive amount of potential investment capital in non-productive liquid assets. Adopting a solution approach developed in Ito and Kurosaki (2009) and generalizing now for any period t, we obtain the reduced form optimal solution as:

$$\bar{W}_t^* = \bar{W}\left(X_t^p, X_t^w, \Sigma\right) \tag{9}$$

$$k_t^* = k\left(X_t^p, X_t^w, \Sigma\right) \tag{10}$$

$$h_t^* = h\left(X_t^p, X_t^w, \Sigma\right) \tag{11}$$

$$a_t^* = a\left(X_t^p, X_t^w, \Sigma\right) \tag{12}$$

where each investment component is represented as a share of total household wealth (net of current period consumption) where a_t, k_t, and h_t represent the share of net wealth $\bar{W}_t$ allocated to liquid savings, own-farm assets and non-farm assets respectively with $A_t = a_t\bar{W}_t$, $K_t = k_t\bar{W}_t$ and $H_t = h_t\bar{W}_t$; X_t^p is a vector of household characteristics including shifters of preferences such as those affecting risk aversion, X_t^w is a vector of characteristics including other fixed capital and human capital.[63] The variance/covariance of $\tilde{\theta}_k$, $\tilde{\theta}_h$ and $\tilde{\theta}_a$ is represented by Σ. It is also worth emphasising that only those households with access to sufficient capital for investment or specific skills for entrance into the non-farm sectors might decide to do so. Other less well endowed households may decide to hoard more liquid savings in an attempt to preserve ex post consumption outcomes while the poorest may have little choice but to bear the risk. Understanding the motivations behind household capital investment decision making is therefore a focus of the empirical section.[64]

The degree to which ex ante household investment diversification reduces the overall covariant risk facing the household crucially depends on the relative variances of own-farm risk σ_k^2, the variance of non-farm risk σ_h^2 , the variance of risk to savings σ_a^2 and the degree to which the random variables $\tilde{\theta}_k$, $\tilde{\theta}_h$ and $\tilde{\theta}_a$ are correlated as represented by the correlation

[63] We abstract here from the aggregate household inter-temporal savings decision (in a similar fashion to Fafchamps et al. (1998)) and treat the level of aggregate saving $\bar{W}$as given.

[64] We consider other frictions (for example, wealth constraints, credit constraints) in the empirical estimation - these are not explicitly represented theoretically for ease of exposition.

coefficients ρ_{kh}, ρ_{ka} and ρ_{ah}.[65] To stylize typical scenarios within rural Vietnam, we assume in general that own-farm returns are imperfectly correlated with returns to non-farm activities ($\rho_{kh} \neq 1$) whereby this imperfect correlation can serve to further reduce the overall covariant risk the household faces. We further hypothesise that the household makes additional savings in liquid asset form. Under these specific assumptions it is likely that the optimal household capital investment choices (represented as shares of total household wealth less consumption) exhibit the following main testable relationships:

$$\frac{\partial k_t^*}{\partial \sigma_k} < 0, \frac{\partial h_t^*}{\partial \sigma_k} > 0, \frac{\partial a_t^*}{\partial \sigma_k} > 0, \tag{13}$$

where σ_k is the coefficient of variation of the own-farm risk facing the household, $\tilde{\theta}_k$.[66] The three terms in equation (13) determine the overall household capital investment portfolio adjustment to risk. The first term indicates that the share of household wealth allocated to own-farm investment declines as total household profits are subject to greater own-farm risk. The second term (which is a corollary of the first term) indicates that the share of household wealth allocated to non-farm investment increases with own-farm risk as a means of overall risk diversification. The third term signals that the share of household wealth allocated to savings in liquid assets is also increased by the household in response to increased own-farm profit risk.

3.3 Empirical Considerations

The main theoretical predictions can be summarized in the following way. First, equation (8) which presents the associated theoretical equilibrium relationships across the three investment classes, predicts that in the absence of full insurance markets and facing own-farm covariant risk, a risk-averse household will invest *less* than total profit maximum levels in own-farm assets and invest *more* than total profit maximum levels in non-farm assets in an attempt to income smooth through risk diversification. Second, equation (8) predicts that a risk-averse household *over*-saves in non-productive liquid assets which may also be an attempt to buffer against future profitability shocks.

[65] Implicit in this statement is household risk-aversion. It is assumed in this context that household risk-aversion is sufficiently strong in order to motivate the household to seek to eliminate all the risk it faces through income/total profit stream diversification (income smoothing) together with savings in liquid form (to facilitate ex post consumption smoothing).

[66] Please refer to the Appendix 3.1 which accompanies this chapter for a full derivation of equations (9), (10), (11), (12) and (13).

To test these predictions, we broadly follow Carter et al. (2007) and Dercon and Christiaensen (2011) and construct our dependent variable as the change in the share of household wealth allocated to each of own-farm assets, non-farm assets and liquid assets from period $t-1$ to period t. We specifically examine the change in the shares of household wealth across capital investment categories in order to isolate any risk induced portfolio allocation trade-offs from attempts at rebuilding capital stock in response to a shock. We also test the robustness of our results against appropriate measures of capital asset levels. These issues are considered in more detail in the empirical section 3.5. Thus, the reduced form for the change in each asset share j is given by:

$$g_{jit} = \theta_{it-1}\beta + \mathbf{X}_{it}\boldsymbol{\beta}_x + \mathbf{s}_{it}\boldsymbol{\beta}_s + v_i + \tau_t + \varepsilon_{it} \tag{14}$$

where v_i are household fixed-effects, τ_t control for average time specific effects and ε_{it} is a random error. θ_{it-1} is the measure of own-farm profit risk, $\mathbf{X}_{it}$ is a vector of household characteristics including preference shifters, and $\mathbf{s}_{it}$ is a vector of current period realisations of adverse income shocks of different types.[67,68] The testable predictions from equation (13) are given by:

$$\frac{\partial g_{kit}}{\partial \theta_{it-1}} < 0, \frac{\partial g_{hit}}{\partial \theta_{it-1}} > 0, \frac{\partial g_{ait}}{\partial \theta_{it-1}} > 0 \tag{15}$$

We are also interested in empirically examining the extent to which risk-induced allocations of capital investment and liquid capital result in departures of total profit returns from profit maximum levels and whether such departures could be attributed (at least in part) to risk aversion or to other factors such as credit constraints. Our theoretical model predicts that risk adjusted ex post period two total profit returns are represented as:

[67] We argue that the problem of endogenous placement (as discussed in Fafchamps (2010)) is not as significant in rural Vietnam due to some government restrictions on the freedom to relocate, although it cannot be dismissed from consideration.

[68] Although we include preference shifters (for example, size of household) in our estimation, we must assume homogeneous risk preferences – at least within different wealth groupings. In line with this assumption, we disaggregate all estimations by wealth group and explore whether differences in asset accumulation trajectories can be directly attributed to household specific constraints or whether differences in risk preferences emerge as the most plausible underlying explanation (controlling where possible for other effects).

$$W = \bar{W}(a^* + \Delta) + \theta_a \pi(\bar{W}(a^* + \Delta)) + \bar{W}(k^* - \Delta) + \theta_k \pi(\bar{W}(k^* - \Delta)) + \bar{W}(h^* + \Delta) + \theta_h \pi(\bar{W}(h^* + \Delta)) \quad (1a)$$

where Δ indicates the extent to which the presence of risk is predicted to deviate household investment and savings allocations from their profit maximizing levels. To empirically assess the profitability impact of household investment and savings behaviour we characterise the household profit function using a variant of the normalized quadratic form adopted by Rosenzweig and Binswanger (1993), Okoruwa et al. (2009) and Hattink et al. (1998) whereby all own-farm capital assets, non-farm capital assets and liquid asset savings are normalized by total household wealth holdings.

The baseline normalized quadratic profit function for each household i in period t is given by:

$$\pi_{it} = \sum_j \beta_j \delta_{jit} + \frac{1}{2} \sum_j \sum_l \beta_{jl} \delta_{jit} \delta_{lit} + \nu_i + \tau_t + \varepsilon_{it} \quad (16)$$

where δ_{jit} are shares of each asset j in total household wealth and π_{it} is the total profit derived from the income generating activities of the household normalized by total household wealth. As in Rosenzweig and Binswanger (1993) we also control for, $\mathbf{Z}_{it}$, a vector of household time-varying characteristics together with productivity measures that could also impact on profit and $\mathbf{s}_{it}$, the vector of current period realizations of adverse income shocks of different types. The full profit function to be estimated is given in equation (17).

$$\pi_{it} = \sum_j \beta_j \delta_{jit} + \tfrac{1}{2} \sum_j \sum_l \beta_{jl} \delta_{jit} \delta_{lit} + \boldsymbol{Z_{it}\beta_Z} + \boldsymbol{s_{it}\beta_s} + \nu_i + \tau_t + \varepsilon_{it} \quad (17)$$

We assume that the parameters in equation (17) are generalizable across all households within our sample and that they only represent the production technology. This latter assumption is predicated on the assumption that any variable inputs are allocated in fixed proportion to productive own-farm and non-farm assets and that given the chosen set of δ_j investment shares, households maximize current period profits based on outcomes after all investment decisions have been taken and after all current period covariant natural, economic and other idiosyncratic risk is realized.

Calculation of the marginal profit level effects, $\partial\pi/\partial\delta_j$, provides quantitative evidence of any over/under investment decision making across each investment share category relative to a base category of the own-farm capital share. Our results are then tested against our main theoretical predictions, namely that in the face of own-farm natural risk; 1) liquid asset holdings are *over*-invested in by risk averse households relative to own-farm capital (which may combine a precautionary with a diversification component) while 2) productive investments in non-farm activities also suffer from *over*-investment relative to own-farm capital (indicative of a diversification component). A corollary to these results is that households *under*-invest in risky own-farm capital – relative to total profit maximized allocations.[69]

3.4. Data

The data are taken from the Vietnam Access to Resources Household Survey (VARHS) for 2006, 2008 and 2010 (CIEM et al., 2007; 2009; 2011). This survey was conducted in rural areas of 12 provinces of Vietnam in June, July and August of each year producing a balanced panel of 2,045 households spread over 161 districts and 456 communes. The VARHS explores issues surrounding Vietnamese rural households' access to resources and the constraints that households face in managing their livelihoods. Along with detailed demographic information on household members, the survey includes details on household capital investments, forms of savings, own-farm and non-farm input purchase and output values together with categories of income shocks.

The raw data on household time use confirm the importance of agricultural activities for households with an average of 50 per cent of annual total labour hours allocated to agriculture alone in 2010. The importance of wage related activities is also increasing with an average of 31 per cent of annual household labour hours devoted to this activity while an average of 14 per cent of annual total labour hours is allocated to non-farm small enterprise activities (the remaining share of time is allocated to common property resource activities). Furthermore, as households directly consume an average of 40 per cent of their own annual

[69] Our conceptual discussion does not explicitly consider any household departures from productive or allocative efficiency. Rather, we concentrate our analysis solely on departures from profit maximization due to the non-separation of household production and consumption decisions under incomplete insurance markets.

crop produce, the raw income data may understate the importance of agriculture as an income source.

The dependent variable presented in empirical equation (14) is constructed as the change in the *share* of total household wealth allocated to each of own-farm assets, non-farm assets and liquid assets from period $t-1$ to period t. First, to construct a monetary value for total household own-farm assets, we aggregate current values for 1) livestock animals (including draught animals such as buffalo, horses; milk animals such as cows, goats; other animals such as pigs, sheep, chickens, ducks, quails); 2) traditional farm implements such as ploughs, carts; 3) modern farm machinery such as feed grinding machines, rice milling machines, grain harvesting machines, pesticide sprayers; 4) modern transport machinery such as motorcycles, bicycles, boats, tractors, cars; 5) reported investment in irrigation equipment. Second, to construct a monetary value for household liquid capital, we aggregate current values for 1) crop stores (including rice and other crops); 2) total savings (including formal savings and informal savings such as ROSCAs together with cash/gold/jewellery held at home). Third, to construct a monetary value for household non-farm investment, we aggregate current values for items including televisions, satellite dishes, dvd players, stereo systems, radio cassette players, telephones, refrigerators, air-conditioners, washing machines, hot water heaters. We argue that most of these items could plausibly be used to assist with non-farm small-enterprise activities (for example, television and radio may be useful for the provision of economic and local market information while washing machines may be useful to support local textile activities) although the data do not explicitly state their uses. Finally, we aggregate all capital investment categories to represent total household wealth and construct shares of total household wealth using the across own-farm investment, non-farm investment and liquid capital investment values. All investment monetary values are inflation adjusted to 2010 present values using external data from the General Statistics Office of Vietnam.

The dependent variable presented in empirical equation (17) represents the household current period total profit derived from all productive activities. We compute household profit measures (across each of 1) crop related activities, 2) livestock/aquaculture produce activities, 3) small-enterprise activities) as per Rosenzweig and Binswanger (1993) by subtracting from agricultural receipts all reported costs including the reported cost of labour used in production. The individual household profit components are then aggregated to derive a total household profit monetary value which is employed in the empirical analysis. All

profit variables are inflation adjusted to 2010 present values using external data from the General Statistics Office of Vietnam. Mean household profits recorded in 2010 are 24,365 ('000VND) with an average of 11,000 ('000 VND) for the poorest households.

The full set of explanatory and dependent variables used in this analysis is described in Table 3.1.

Table 3.1: Variables and their descriptions

Dependent Variable	Variable Label	Description
Aggregate Liquid Capital Investment Share	δ_{it} equations (16), (17)	Share of household total wealth allocated to liquid capital derived from a monetary value for household liquid capital as a fraction of total household wealth. Liquid capital is constructed by aggregating current values for 1) crop stores (including rice and other crops); 2) total savings (including formal savings and informal savings such as ROSCAs together with cash/gold/jewellery held at home).
Aggregate Non-Farm Investment Share	δ_{it} equations (16), (17)	Share of household wealth allocated to non-farm capital derived from a monetary value for household non-farm capital as a fraction of total household wealth. Non-farm capital is constructed by aggregating current values for items including televisions, satellite dishes, dvd players, stereo systems, radio cassette players, telephones, refrigerators, air-conditioners, washing machines, hot water heaters.
Aggregate Own-Farm Investment Share	δ_{it} equations (16), (17)	Share of household wealth allocated to own-farm capital derived from a monetary value for household own-farm capital as a fraction of total household wealth. Non-farm capital is constructed by aggregating current values for 1) livestock animals (including draught animals such as buffalo, horses; milk animals such as cows, goats; other animals such as pigs, sheep, chickens, ducks, quails); 2) traditional farm implements such as ploughs, carts; 3) modern farm machinery such as feed grinding machines, rice milling machines, grain harvesting machines, pesticide sprayers; 4) modern transport machinery such as motorcycles, bicycles, boats, tractors, cars; 5) reported investment in irrigation equipment.
Disaggregated Own-Farm Investment Shares comprising:		
Draught Animals Investment Share	δ_{it} equations (16), (17)	Share of household total wealth allocated to draught animals derived from a monetary value for draught animals as a fraction of total household wealth. Draught animals are constructed by aggregating values for buffalo, horses.
Milk Animals Investment Share	δ_{it} equations (16), (17)	Share of household total wealth allocated to milk animals derived from a monetary value for milk animals as a fraction of total household wealth. Milk animals are constructed by aggregating values for cows, goats.
Other Animals Investment Share	δ_{it} equations (16), (17)	Share of household total wealth allocated to other animals derived from a monetary value for other animals as a fraction of total household wealth. Other animals are constructed by aggregating values for pigs, sheep, chickens, ducks, quails.
Traditional Farm Implements Investment Share	δ_{it} equations (16), (17)	Share of household total wealth allocated to traditional farm implements derived from a monetary value for traditional farm implements as a fraction of total household wealth. Traditional farm implements are constructed by aggregating values for ploughs, carts.
Transport Machinery Investment Share	δ_{it} equations (16), (17)	Share of household total wealth allocated to transport machinery derived from a monetary value for transport machinery as a fraction of total household wealth. Transport machinery is constructed by aggregating values for motorcycles, bicycles, boats, tractors, cars.
Modern Farm Machinery Investment	δ_{it} equations (16), (17)	Share of household total wealth allocated to modern farm machinery derived from a monetary value for modern

Share		farm machinery as a fraction of total household wealth. Modern farm machinery is constructed by aggregating values for feed grinding machines, rice milling machines, grain harvesting machines, pesticide sprayers.
Investment Share in Land Irrigation	δ_{it} equations (16), (17)	Share of household total wealth allocated to irrigation derived from a monetary value for current period land irrigation investment as a fraction of total household wealth.
Total Household Profit	π_{it} equations (16), (17)	Measure of household total profit (aggregated for each of 1) crop related activities, 2) livestock/aquaculture produce activities, 3) small-enterprise activities) by subtracting from agricultural receipts all reported costs including the reported cost of labour used in production.
Explanatory Variable	**Variable Label**	**Description**
Exogenous: Covariant Natural Risk	θ_{it-1} equation (14)	*Proxy Variable:* Dummy variable indicating whether the household has suffered a spatially covariant natural income shock during period $t-2$ to period $t-1$. Such lagged shocks include floods, landslides, typhoons, storms, droughts, pest infestation, crop disease and avian flu.
Exogenous: Covariant Economic Risk	Element of vector $\boldsymbol{X_{it}}$ equation (14)	*Proxy Variable:* Dummy variable indicating whether the household has suffered an exogenous economic shock during period $t-2$ to period $t-1$. Shocks include changes in crop price, changes in key input prices, changes in prices of food or other essential commodities consumed.
Idiosyncratic: Insurable Risk	Element of vector $\boldsymbol{X_{it}}$ equation (14)	*Proxy Variable:* Dummy variable indicating whether the household has suffered an idiosyncratic insurable income shock during period $t-2$ to period $t-1$. Shocks include illness, injury or death of a family member.
Idiosyncratic: Uninsurable Risk	Element of vector $\boldsymbol{X_{it}}$ equation (14)	*Proxy Variable:* Dummy variable indicating whether the household has suffered an idiosyncratic uninsurable income shock during period $t-1$to period $t-2$. Shocks include unemployment, unsuccessful investment, loss of land, crime/robbery/theft, divorce, family disputes.
Exogenous: Natural Shock	Element of vector $\boldsymbol{s_{it}}$ equation (14)	Dummy variable indicating whether the household has suffered a current period spatially covariant natural income shock.
Exogenous: Economic Shock	Element of vector $\boldsymbol{s_{it}}$ equation (14)	Dummy variable indicating whether the household has suffered a current period exogenous economic shock.
Idiosyncratic: Insurable Shock	Element of vector $\boldsymbol{s_{it}}$ equation (14)	Dummy variable indicating whether the household has suffered a current period idiosyncratic insurable income shock.
Idiosyncratic: Uninsurable Shock	Element of vector $\boldsymbol{s_{it}}$ equation (14)	Dummy variable indicating whether the household has suffered a current period idiosyncratic uninsurable income shock.
Not Recovered (Prior)	Element of vector $\boldsymbol{X_{it}}$ equation (14)	Dummy variable indicating whether the household has NOT recovered from income shocks suffered during period $t-2$ to period $t-1$.
Natural Share Loss (Prior)	Element of vector $\boldsymbol{X_{it}}$ equation (14)	Share of household income lost due to natural shocks suffered during period $t-2$ to period $t-1$.
Not Recovered (Current)	Element of vector $\boldsymbol{X_{it}}$ equation (14)	Dummy variable indicating whether the household has NOT recovered from income shocks in the current time period.
External Transfers	Element of vector $\boldsymbol{X_{it}}$ equation (14)	Dummy variable indicating whether the household has received external income transfers from government and/or family members/relatives (public/private sources).
Formal Insurance	Element of vector $\boldsymbol{X_{it}}$ equation (14)	Dummy variable indicating whether the household has holds formal insurance - insurance claims are restricted to

		health and life insurance.
Credit	Element of vector $\boldsymbol{X}_{it}$ equation (14)	Dummy variable indicating whether the household has outstanding borrowings – either from formal or informal sources.
Wage Income (Log)	Element of vector $\boldsymbol{X}_{it}$ equation (14)	Wage income from external sources ('000 VND): *Note*: Includes zero income values as ln(wage income + 1) executed. (2010 mean = 116711 VND, 2010 std deviation=26497 VND)
Household Size	Element of vector $\boldsymbol{X}_{it}$ equation (14)	Total number of household members.
Education of Household Head	Element of vector $\boldsymbol{X}_{it}$ equation (14)	1 "Cannot read and write" 2 "Can read & write but did not finish primary school" 3 "Finished primary school" 4 "Finished lower secondary school" 5 "Finished upper secondary school" 6 "Third Level"
Age of Household Head	Element of vector $\boldsymbol{X}_{it}$ equation (14)	Measured in years.
Total Area Farmed	Element of vector $\boldsymbol{X}_{it}$ equation (14)	Measured in hectares.
Share of Land Irrigated	Element of vector $\boldsymbol{X}_{it}$ equation (14)	Measured in years.
Manual Irrigation	Element of vector $\boldsymbol{X}_{it}$ equation (14)	Indicator variable indicating whether plot area/or part-of is manually irrigated.
Crop Restrictions	Element of vector $\boldsymbol{X}_{it}$ equation (14)	Indicator variable indicating whether exogenous crop restrictions apply to land.
Share of Steep Land	Element of vector $\boldsymbol{X}_{it}$ equation (14)	Variable measuring the share of land which is steeply sloped.
Land Problem Indicator	Element of vector $\boldsymbol{X}_{it}$ equation (14)	Indicator variable indicating whether problems have been experienced with land quality.
Share of Land at Canal Head	Element of vector $\boldsymbol{X}_{it}$ equation (14)	Variable measuring the share of land adjacent to the head of the commune canal.
Share of Land with no Infrastructure	Element of vector $\boldsymbol{X}_{it}$ equation (14)	Variable measuring the share of land with no infrastructure.
Age of Household Head	Element of vector $\boldsymbol{X}_{it}$ equation (14)	Measured in years.
Total Household Wealth	Element of vector $\boldsymbol{X}_{it}$ equation (14)	Total household wealth constructed using fixed asset values (irrigation equipment, livestock, farm machinery), liquid asset values (savings, crop stores) and all consumer durables ('000 VND): (2010 mean = 56489 VND, 2010 std deviation=201607 VND)

Incidences of covariant natural shocks are an important feature of rural life in Vietnam. Our data indicate that 43 per cent of all households suffered a natural event in 2008 with an average loss of 28 per cent of annual income for the poorest households.[70] A key consideration in our empirical analysis is the measure of ex ante income risk. We measure farm specific risk as observed past realizations of covariant natural risks. One complication of using such a measure is that it may impact to varying degrees on *both* own-farm and non-

[70] See Wainwright and Newman (2011) for more details of incidences of income shocks and their impact on household liquid assets and consumption levels.

farm profitability. However, simple fixed effects estimates of the effects of instances of commune level natural shocks on ex post profitability measures reveal that realizations of natural risk affects own-farm profitability to a greater extent than non-farm profitability.[71] This relationship is preserved across all wealth groups. By contrast results suggest that covariant natural shocks have no significant impact upon household profit from non-farm activities (for example, profits generated by home garment making and selling) – a relationship which is also preserved across wealth groups.[72] Taken together these results validate our measure of income risk and our assumption that the variance of own-farm risk (as empirically measured through the impact of natural shocks on own-farm profitability) is greater than that of non-farm risk.

Although the focus of our analysis is on the impact of exogenous covariant natural risk on household decision making, we also control for forms of economic risk (which is also considered exogenous to the household) together with categories of household idiosyncratic risk.[73] We categorise idiosyncratic risk as per Wainwright and Newman (2011) and disaggregate into 1) insurable risk (for example, illness, injury or death of household member) and 2) uninsurable risk (for example divorce, family disputes etc).[74]

Against this backdrop we are interested in household capital accumulation trends and whether households with greater natural risk expectations (hypothesized to arise as a direct result of suffering prior period natural shocks) exhibit different capital share allocation trajectories. We adopt a similar empirical approach to Rosenzweig and Binswanger (1993) and aggregate the detailed information on household (annual) asset holdings into three categories, by value, inflation adjusting to 2010 prices and constructing each as a share of total household wealth. The categories included are: 1) own-farm capital consisting of draught animals, including buffalo and horses/ponies; milk animals; other animals, including pigs, sheep, chickens, ducks and quails; traditional farm implements, including manual ploughs and carts; modern

[71] Results suggest that covariant commune level natural shocks reduce total farm profits within households by 58 per cent over the time period.

[72] These results are presented in Tables 3.2.1 (effect of shocks on own-farm profitability) and 3.2.2 (effect of shocks on non-farm profitability) of Appendix 3.2 which accompanies this chapter.

[73] We treat economic risk (for example, the risk of crop price changes, key input price changes/shortages) as exogenous as we assume that each household is a price taker in this context.

[74] We emphasise as per Wainwright and Newman (2011) that markets for formal health insurance and life insurance are available to households in our sample. In addition, households can purchase fire insurance and education insurance. Hence, we consider idiosyncratic events such as illness, injury and death to be 'insurable' in this context while other idiosyncratic events such as divorce and family disputes are 'not insurable' due to missing insurance markets.

machinery, including feed grinding machines, rice milling machines, grain harvesting machines and pesticide sprayers; transport machinery, including motorcycles, bicycles, boats, tractors and cars and the value of land irrigation investments; 2) total liquid assets, including all forms of formal and informal savings and crop stores; 3) non-farm assets, including personal computers, telephone, refrigerator, air-conditioner, washing machines and hot water heaters, and durables including colour and black and white television, satellite dish, video or dvd player, stereo system and telephone. The raw data reveal that on average households hold approximately 50 percent of their wealth holdings in own-farm assets, 15 per cent in non-farm assets and 34 percent in forms of liquid savings.[75]

This asset composition also facilitates a disaggregated understanding of the underlying dynamics of capital accumulation where all components, with the exceptions of liquid capital and non-farm assets, are considered to be categories of own-farm investment. Tables 3.2a, 3.2b and 3.2c detail mean aggregate own-farm, non-farm and liquid capital investment share changes, respectively.

Table 3.2a: Mean Aggregate Own-Farm Investment Share Changes 2010

	Overall	Suffered lagged natural shocks	Not suffered lagged natural shocks
Full Sample	-0.05	-0.07	-0.03
Lowest Wealth Group	-0.04	-0.11	-0.01
Middle Wealth Group	-0.001	-0.02	0.02
Highest Wealth Group	-0.11	-0.12	-0.11

Table 3.2b: Mean Aggregate Non-Farm Investment Shares Changes 2010

	Overall	Suffered lagged natural shocks	Not suffered lagged natural shocks
Full Sample	-0.01	0.001	-0.012
Lowest Wealth Group	0.03	0.03	0.02
Middle Wealth Group	-0.01	0.001	-0.02
Highest Wealth Group	-0.38	-0.02	-0.05

Table 3.2c: Mean Aggregate Liquid Investment Share Changes 2010

	Overall	Suffered lagged natural shocks	Not suffered lagged natural shocks
Full Sample	0.06	0.07	0.05
Lowest Wealth Group	0.02	0.08	-0.02
Middle Wealth Group	0.01	0.02	0.003
Highest Wealth Group	0.15	0.14	0.16

[75] In the absence of reliable land valuations we omit land values from the category of own-farm assets and include suitable controls for land quality (including land size and its square in hectares) in our profit estimations.

Table 3.2a details the changes in own-farm investment (as a share of total household wealth) for the year 2010. We find that the poorest households suffering from prior natural shocks reduce their share of non-farm assets more than those households that do not experience prior shocks. Noteworthy is the fact that the middle wealth group of households *increase* the share of total wealth allocated to own-farm capital. We also find that households in the lowest wealth group exhibit allocations in the direction predicted by the theory. Inspection of non-farm investment (as a share of total household wealth) from Table 3.2b appears also consistent with theory for the lowest and middle wealth groups of households whereby the share of total wealth allocated to non-farm capital marginally increases for households suffering prior natural shocks. Table 3.2c reveals that the share of household wealth allocated to liquid capital also increases for all households suffering prior natural shocks may be suggestive of precautionary saving.[76] An exploration of whether non-farm related capital investment, own-farm capital investment and liquid asset savings is risk-induced (together with profit level consequences) is the main focus of the empirical analysis.

3.5 Empirical Results

The first part of our empirical investigation estimates equation (14) for changes in own-farm, non-farm and liquid capital shares in order to test the predictions detailed in equation (15), namely to determine whether the presence of covariant risk, proxied by lagged realizations of natural shocks, acts as a significant predictor of household capital allocation decisions. In addition to our proxies for covariant natural risk, we include measures of economic and idiosyncratic risk and controls for forms of current period shocks, household wage income, household size, an indicator of household credit and formal insurance and an indicator of whether the household is in receipt of external transfers. To control for shock persistence and associated efforts at rebuilding asset holdings following a prior natural event, we also include an indicator of whether the household has recovered from prior income shocks.

3.5.1 Own-Farm Investment

Our theoretical model predicts that the presence of covariant natural risk which impacts directly on own-farm profitability should act as a deterrent to own-farm investment growth.

[76] T-tests of the differences in sample means for those households suffering prior natural shocks and those households who did not, confirm significance at the 1% and 5% levels for own-farm investment share changes of the poorest and middle wealth households respectively. By contrast, full sample t-tests of the differences in means for liquid capital and non-farm investment share changes are not statistically significant. Note, however, that a small number of statically significant differences are observed at the district level.

To test this prediction we estimate equation (14) using the change in allocation of aggregate own-farm assets as a share of total household wealth as the dependent variable. We subsequently estimate equation (14) using the change in each disaggregated own-farm asset component (draught animals, milk animals, other animals, traditional farm implements, farm modern machinery, farm transport machinery, irrigation investment) as a share of total household wealth as the disaggregated dependent variables. The aggregate and disaggregated results are presented in Tables 3.3 and 3.4, respectively.

Table 3.3: Fixed Effects Estimates: Effects of Covariate Risk Measures on the Change in Aggregate Own-Farm Investment Shares

Independent Variables	***Dependent Variable*** ***Change in Aggregate Own-Farm Investment Shares***			
	(1) Full Sample	(2) Full Sample	(3) Lowest Wealth Group	(4) Lowest Wealth Group
Natural Risk	-0.036		-0.175***	
	(0.025)		(0.050)	
Weather Risk		-0.020		-0.171**
		(0.032)		(0.069)
Disease Risk		-0.064**		-0.136**
		(0.027)		(0.055)
Economic Risk	-0.032	-0.032	0.054	0.111
	(0.063)	(0.063)	(0.195)	(0.200)
Idio Risk – Insurable	0.030	0.027	0.042	0.034
	(0.032)	(0.032)	(0.061)	(0.063)
Idio Risk – Not insured	0.028	0.031	0.248**	0.238*
	(0.063)	(0.064)	(0.125)	(0.125)
Not Recovered (Prior)	-0.019	-0.012	-0.048	-0.054
	(0.030)	(0.030)	(0.058)	(0.059)
Natural Shocks	0.043*		0.009	
	(0.024)		(0.049)	
Weather Shocks		0.025		-0.008
		(0.027)		(0.057)
Disease Shocks		-0.011		-0.051
		(0.026)		(0.053)
Economic Shocks	-0.002	-0.005	-0.071	-0.042
	(0.057)	(0.056)	(0.188)	(0.196)
Idio Shocks – Insurable	0.015	0.011	0.022	0.006
	(0.034)	(0.034)	(0.063)	(0.066)
Idio Shocks – Not insurable	0.039	0.042	0.148	0.143
	(0.053)	(0.054)	(0.105)	(0.106)
Not Recovered (Current)	-0.011	0.005	-0.046	-0.025
	(0.027)	(0.027)	(0.054)	(0.055)
Natural Share Loss (Prior)	0.000	0.000	0.004***	0.004***
	(0.000)	(0.000)	(0.001)	(0.001)
Other Share Loss (Prior)	-0.027	-0.028	-0.068	-0.062
	(0.023)	(0.023)	(0.054)	(0.054)
Natural Share Loss (Current)	0.052***	0.053***	0.055***	0.054***
	(0.018)	(0.018)	(0.011)	(0.012)
Other Share Loss (Current)	0.022	0.018	-0.002	-0.004
	(0.021)	(0.022)	(0.059)	(0.060)
Credit Indicator	0.058***	0.060***	0.007	0.007
	(0.021)	(0.021)	(0.040)	(0.040)
Formal Insurance Indicator	0.056***	0.056***	0.084*	0.083*
	(0.022)	(0.022)	(0.043)	(0.043)
External Transfer Indicator	0.016	0.018	0.029	0.032
	(0.020)	(0.020)	(0.041)	(0.041)
Wage Income (Log)	-0.006**	-0.006**	-0.006	-0.005
	(0.003)	(0.003)	(0.005)	(0.005)
Education	Yes	Yes	Yes	Yes
Household Size	0.016	0.015	0.052*	0.053*
	(0.014)	(0.014)	(0.028)	(0.028)
Age Controls	Yes	Yes	Yes	Yes
Time Dummies	Yes	Yes	Yes	Yes
Constant	0.031	0.052	-0.104	-0.119
	(0.210)	(0.210)	(0.336)	(0.338)
Observations	4025	4025	1319	1319
R-squared	0.069	0.068	0.095	0.091
Number of HHid	2037	2037	675	675

Robust standard errors are clustered at the household level and are given in parenthesis. *** indicates significance at the 1% level, ** indicates significance at the 5% level, * indicates significance at the 10% level.

Examining first the aggregated own-farm share results presented in Table 3.3 and using the full sample we find that the presence of natural risk is a negative yet insignificant predictor of own-farm asset share changes over time (Column 1). Disaggregating natural risk into disease related and weather related components (Column 2) we find that disease related risk (for example, pest infestation or crop disease) acts as a deterrent to risky own-farm capital accumulation. The risk of diseases reduces the share of risky non-farm capital by 6 per cent.

Crucial to our understanding of how risk affects household investment behaviour is an exploration of the specific constraints facing these households.[77] In an effort to disentangle any investment impact of intrinsic household risk aversion from specific wealth constraints we disaggregate households by wealth group. Results for households in the lowest wealth group (Column 3) reveal that, consistent with theoretical predictions, covariant risk proxied by lagged natural shocks reduces the share of household investment in risky own-farm capital by 17 per cent. This result lends support to the hypothesis discussed by Mendola (2007) that the poorest most vulnerable households are more likely to sacrifice expected profits for more self-protection in the form of income diversification.

The results for households in the middle and high wealth groups reveal that natural risk is a negative yet insignificant predictor of own-farm investment behaviour. Column 4 disentangles natural shocks for the poorest households and results suggest that the impacts of *both* weather risk and disease risk are negative and statistically significant. The presence of weather risk decreases the household share of own farm investment by 17 per cent while disease risk leads to a 14 per cent reduction. This result highlights the importance of natural disasters for household decision making in a geographically vulnerable region such as rural Vietnam.[78]

These results suggest that household risk aversion may be an important motivator underlying this pronounced risk induced own-farm investment behaviour for poorer households. Although credit constraints are not specifically captured in the conceptual framework we also empirically consider the role of credit as another potential underlying mechanism influencing household capital allocation decision process. Results indicate that credit is an insignificant

[77] Binswanger (1980) found that risk aversion variations among rural households facing similar risks were too small to explain the full differential in investment behaviour.

[78] The estimation results for middle and high wealth households are available in Table 3.2.3 of Appendix 3.2 which accompanies this chapter.

predictor of non-farm investment for poor households (Columns 3 and 4) which may be indicative of specific credit constraints. By contrast, the availability of credit features strongly as a determinant of own-farm investment for households when the full sample is considered (Columns 1 and 2) and for the wealthiest households (result shown in Table 3.2.3 of Appendix 3.2). For the full sample, access to credit increases own-farm asset share accumulation by 6 per cent. Moreover, access to formal insurance is also important for own-farm asset share accumulation as highlighted by the result that the availability of formal insurance also increases non-farm asset share accumulation by 6 per cent. Wage income acts as a deterrent to own-farm asset accumulation which suggests that off-farm labour supply may serve as an additional income smoothing device.

Having only modelled forms of covariant risk for ease of theoretical exposition, we do include other forms of non-covariant risk as controls in our empirical estimation.[79] Results for these other types of non-covariant risk indicate that the presence of both forms of idiosyncratic risk (insurable and uninsurable) is a positive yet insignificant predictor of household own-farm asset accumulation when the full sample is considered (Column 1). This result may be capturing the fact that households have other mechanisms for risk-coping with idiosyncratic specific shocks and that their ability to protect consumption in the face of such risks eliminates the requirement for income smoothing. We also find that the presence of idiosyncratic risk which is not insured *increases* the household share of wealth in own-farm assets for poorer households by 24 per cent while the coefficient against idiosyncratic insurable risk although positive is insignificant (Column 3). This result may be capturing the strength of informal risk-coping mechanisms for poorer households whereby the presence of idiosyncratic risk (hypothesised here to be informally insured) acts as an enabler towards more profitable higher risk own-farm investment.[80]

Disaggregating own-farm investment shares for the poorest households in Table 3.4 we find that the share of livestock investment is reduced by 13 per cent in the presence of weather related risk (Column 2). This result is robust to the inclusion of a control for the persistence of lagged income shocks in an attempt to disentangle any risk-induced decisions from efforts to rebuild this stock of assets.

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[79] These idiosyncratic risk controls are proxied in a similar to the covariant risk lagged proxy variables.

[80] The primary results for covariate natural risk are also robust to 1) estimations using the level of aggregate own-farm investment as the dependent variable and 2) estimations using the growth rate of aggregate own-farm investment as the dependent variable.

Table 3.4: Fixed Effects Estimates: Effects of Covariate Risk Measures on the Change in Disaggregated Own-Farm Investment Shares

	Dependent Variable						
	Change in Disaggregated Own-Farm Investment Shares						
Independent Variables	(1) Livestock Investment	(2) Livestock Investment	(3) Draught Animals Investment	(4) Milk Animals Investment	(5) Transport Machinery Investment	(6) Farm Modern Machinery Investment	(7) Investment in Land Irrigation
Natural Risk	-0.024				-0.118***		
	(0.042)				(0.043)		
Weather Risk		-0.133**	-0.198	-0.187		0.035**	0.072
		(0.057)	(0.199)	(0.125)		(0.017)	(0.066)
Disease Risk		0.008	0.048	0.031		-0.005	-0.054
		(0.050)	(0.152)	(0.102)		(0.016)	(0.042)
Economic Risk	0.201	0.257	0.358	-0.017	-0.018	-0.008	-0.369*
	(0.175)	(0.173)	(0.456)	(0.380)	(0.165)	(0.038)	(0.208)
Idio Risk – Insurable	0.003	-0.013	-0.002	-0.005	-0.009	-0.007	-0.035
	(0.050)	(0.051)	(0.165)	(0.143)	(0.050)	(0.013)	(0.043)
Idio Risk – Not Insurable	-0.040	-0.052	-0.136	-0.069	0.241**	-0.013	0.044
	(0.117)	(0.116)	(0.291)	(0.277)	(0.118)	(0.051)	(0.062)
Not Recovered (Prior)	-0.079	-0.065	-0.004	-0.082	0.048	-0.022	0.004
	(0.054)	(0.055)	(0.142)	(0.117)	(0.052)	(0.021)	(0.053)
Weather Shocks		-0.000	-0.077	-0.042		0.017	0.053
		(0.049)	(0.153)	(0.116)		(0.013)	(0.047)
Other Shocks	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Idio Shocks – Not Insurable	-0.077	-0.075	-0.267	-0.169	0.275***	-0.052	0.021
	(0.096)	(0.094)	(0.206)	(0.244)	(0.097)	(0.068)	(0.072)
Not Recovered (Current)	-0.027	-0.019	0.043	-0.064	0.013	-0.015	-0.054
	(0.049)	(0.051)	(0.153)	(0.116)	(0.053)	(0.016)	(0.064)
Credit Indicator	-0.022	-0.029	-0.142	-0.047	0.030	0.008	0.000
	(0.034)	(0.034)	(0.127)	(0.082)	(0.035)	(0.015)	(0.033)
Formal Insurance Indicator	0.032	0.032	0.157	0.129	0.054	-0.011	-0.030
	(0.037)	(0.037)	(0.144)	(0.092)	(0.039)	(0.026)	(0.058)
External Transfer Indicator	0.104***	0.106***	0.100	0.225**	-0.049	-0.009	-0.045
	(0.034)	(0.034)	(0.119)	(0.088)	(0.035)	(0.015)	(0.041)
Wage Income (Log)	0.000	-0.000	0.031	0.005	-0.008	-0.000	-0.001
	(0.004)	(0.004)	(0.019)	(0.011)	(0.005)	(0.001)	(0.004)
Education	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household Size	0.042*	0.046*	0.056	-0.040	0.024	-0.009	-0.001
	(0.025)	(0.025)	(0.097)	(0.067)	(0.025)	(0.007)	(0.022)
Age of Household Head	0.005	0.006	0.020	0.018	-0.003	-0.001	0.017
	(0.013)	(0.013)	(0.048)	(0.046)	(0.011)	(0.004)	(0.014)
Age Squared	0.000	0.000	-0.000	-0.000	-0.000	0.000	-0.000
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-0.593*	-0.603*	-0.728	-0.756	0.102	0.087	-0.190
	(0.344)	(0.342)	(1.038)	(1.145)	(0.305)	(0.127)	(0.399)
Observations	1069	1069	200	297	1192	674	264
R-squared	0.177	0.186	0.400	0.305	0.083	0.040	0.255
Number of HHid	544	544	101	151	604	340	134

Robust standard errors are clustered at the household level and are given in parenthesis.
*** indicates significance at the 1% level, ** indicates significance at the 5% level, * indicates significance at the 10% level.

Further disaggregation of livestock reveals that neither draught animals nor milk animals are significantly impacted by weather risk considerations (Columns 3 and 4). This result is likely explained by the important role that livestock such as pigs, sheep, chickens, ducks and quail serve in rural households whereby they are used *both* to cultivate soil and as important sources of food.

We also find that the presence of (insurable) idiosyncratic risk controls is an insignificant predictor of the change in the share of household wealth allocated to total livestock holdings

(Column 1). Taken together, these findings that investment in livestock *decreases* with forms of covariant natural risk yet is unresponsive to forms of idiosyncratic risk lends support to the evidence presented in Fafchamps et al. (1998) and Dercon (2002) which suggests that livestock serves as an important risk-coping buffer stock in the event of idiosyncratic shocks. That households should not hoard livestock in a pre-emptive response to covariant type risk aligns broadly with the hypothesis that selling these assets is resisted in response to covariant shocks where the prices for livestock will most likely fall.[81]

Turning now to components of own-farm machinery, results reveal that investment in transport machinery, including motorcycles, bicycles, boats, tractors and cars is negatively responsive to forms of natural risk by a magnitude of 12 per cent (Column 5). By contrast, investment in modern farm machinery including feed grinding machines, rice milling machines and grain harvesting machines *increases* with weather specific natural risk (Column 6).[82] In relation to irrigation, we find that while the presence of covariant risk is an insignificant predictor of investment, current period covariant shocks *increase* irrigation as a share of household wealth suggesting that risk induced irrigation responses are reactive rather than pre-emptive (Column 7).

Overall, we find that the presence of natural risk, acts as an inhibitor rather than a driver of household own-farm investment growth (as a share of total household wealth) for the poorest households. A key question now is whether there is evidence of a trade-off between risk-induced own-farm investment, non-farm investment and liquid capital investment as the theory predicts.

3.5.2 Non-Farm Investment

Our theoretical model predicts that the presence of covariant natural risk which impacts mainly on own-farm profitability, induces the household to diversify income into non-farm non-wage economic activities where profitability is found to be insignificantly impacted by

[81] Wainwright and Newman (2011) find a similar result when examining households ex post liquid asset responses to specific categories of income shocks.

[82] We speculate that this result may be explained by the desire for increased own-farm mechanisation (in the face of risk) to both increase own-farm profit levels and potentially release valuable household labour for other non-farm specific uses.

this type of risk. As such, we expect the presence of natural risk to have a positive impact on non-farm aggregate asset growth.[83]

We estimate equation (14) using the change in non-farm assets (as a share of total household wealth) as the dependent variable. The results are presented in Table 3.5.

[83] In the absence of raw data specifically detailing the capital investments that are factor inputs into non-farm small enterprise activities (although we do observe small enterprise income and expenditure data), we assume that any non-farm capital assets such as consumer durables/home assets are associated with non-farm enterprise activities. We do acknowledge that some transport specific capital assets which are classified as own-farm related may also be used for non-farm purposes – although we cannot say this conclusively. Results for own-farm investment are robust to a sensitivity reclassification of motorcycles/bicycles/cars as non-farm capital (from own-farm capital). Further, results for non-farm investment are strengthened by this reclassification. Further, we consider Table 3.4 which disaggregates components of own-farm investment as another suitable robustness check.

Table 3.5: Fixed Effects Estimates: Effects of Covariate Risk Measures on the Change in Aggregate Non-Farm Investment Shares

	Dependent Variable			
	Change in Aggregate Non-Farm Investment Shares			
Independent Variables	(1) Full Sample	(2) Full Sample	(3) Lowest Wealth Group	(4) Lowest Wealth Group
Natural Risk	0.018		0.044	
	(0.015)		(0.034)	
Weather Risk		0.026		0.030
		(0.018)		(0.046)
Disease Risk		0.012		0.030
		(0.017)		(0.042)
Economic Risk	0.010	0.008	0.068	0.055
	(0.032)	(0.032)	(0.101)	(0.102)
Idio Risk – Insurable	-0.014	-0.013	-0.059	-0.060
	(0.022)	(0.023)	(0.051)	(0.052)
Idio Risk – Not insured	0.087**	0.088**	-0.098	-0.099
	(0.037)	(0.037)	(0.087)	(0.088)
Not Recovered (Prior)	0.001	-0.001	0.050	0.056
	(0.019)	(0.019)	(0.043)	(0.043)
Natural Shocks	-0.011		-0.002	
	(0.015)		(0.034)	
Weather Shocks		0.009		-0.007
		(0.016)		(0.041)
Disease Shocks		-0.012		0.006
		(0.015)		(0.039)
Economic Shocks	0.043*	0.043*	0.040	0.033
	(0.025)	(0.025)	(0.089)	(0.090)
Idio Shocks – Insurable	-0.021	-0.019	-0.064	-0.063
	(0.022)	(0.023)	(0.054)	(0.056)
Idio Shocks – Not insurable	0.047*	0.047*	-0.034	-0.034
	(0.028)	(0.028)	(0.064)	(0.064)
Not Recovered (Current)	0.017	0.014	0.057	0.056
	(0.017)	(0.017)	(0.038)	(0.039)
Natural Share Loss (Prior)	-0.000	-0.000	-0.004***	-0.004***
	(0.000)	(0.000)	(0.001)	(0.001)
Other Share Loss (Prior)	0.045**	0.045**	0.125**	0.124*
	(0.021)	(0.021)	(0.064)	(0.064)
Natural Share Loss (Current)	-0.010	-0.010	-0.002	-0.001
	(0.010)	(0.010)	(0.009)	(0.009)
Other Share Loss (Current)	0.011	0.011	0.077	0.077
	(0.019)	(0.019)	(0.074)	(0.074)
Credit Indicator	0.029**	0.029**	0.013	0.013
	(0.012)	(0.012)	(0.026)	(0.027)
Formal Insurance Indicator	0.002	0.002	-0.011	-0.010
	(0.014)	(0.014)	(0.033)	(0.034)
External Transfers Indicator	-0.004	-0.003	-0.025	-0.026
	(0.011)	(0.011)	(0.026)	(0.026)
Wage Income (Log)	0.002	0.002	-0.000	-0.000
	(0.002)	(0.002)	(0.003)	(0.003)
Education	Yes	Yes	Yes	Yes
Household Size	-0.012	-0.012	-0.029	-0.029
	(0.008)	(0.008)	(0.018)	(0.018)
Age of Household Head	0.007	0.007	0.008	0.007
	(0.006)	(0.006)	(0.011)	(0.011)
Age Squared (HH Head)	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Time Dummies	Yes	Yes	Yes	Yes
Constant	-0.067	-0.076	0.051	0.055
	(0.145)	(0.146)	(0.280)	(0.283)
Observations	4025	4025	1319	1319
R-squared	0.024	0.024	0.060	0.059
Number of HHid	2037	2037	675	675

Robust standard errors are clustered at the household level and are given in parenthesis.
*** indicates significance at the 1% level, ** indicates significance at the 5% level, * indicates significance at the 10% level.

For the full sample of households we do not find a statistically significant relationship between natural risk and the share change of household wealth allocated to non-farm assets

(Column 1). Exploring wealth effects also reveals no significant effect of natural risk on the share of non-farm investment for any wealth group (although natural risk coefficients for all wealth groups are also positive). This result is most likely explained by the dispersion of households engaged in non-farm activities across all wealth groups whereby we find that only 18 per cent of poor households report to undertake non-farm activities while 27 per cent of mid-wealth households and 39 per cent of the wealthiest households engage in such activities. Furthermore, inspection of raw data on time allocations is suggestive that poor households devote a greater share of their total labour allocation to non-farm activities in the presence of natural risk than otherwise would be the case. This illustrates that household efforts directed at non-farm diversification activities may be weighted more towards labour than capital adjustments.

Turning now to other control variables we find that the presence of uninsured idiosyncratic risk significantly increases the share of household wealth allocated to non-farm investment (also Column 1). Access to credit is also significant for non-farm investment accumulation but not for the poorest households. Taken together these results suggest that wealthier households are more concerned with income diversification in the presence of idiosyncratic risk and have the credit facility to do so. For poor households, although natural risk positively relates to non-farm asset accumulation, the result is not significant which suggests that constraints may play a role in investment diversification decisions.[84]

3.5.3 Liquid Capital Investment

To determine whether own-farm natural risk induces the household to save in liquid asset holdings, we estimate equation (14) using the change in non-productive liquid assets (as a share of total household wealth) as the dependent variable. The results are presented in Table 3.6.

[84] The primary results for covariate natural risk are also robust to 1) estimations using the level of aggregate non-farm investment as the dependent variable and 2) estimations using the growth rate of aggregate non-farm investment as the dependent variable

Table 3.6: Fixed Effects Estimates: Effects of Covariate Risk Measures on the Change in Aggregate Liquid Capital Shares

	Dependent Variable			
	Change in Aggregate Liquid Capital Shares			
Independent Variables	(1) Full Sample	(2) Full Sample	(3) Lowest Wealth Group	(4) Lowest Wealth Group
Natural Risk	0.018		0.132***	
	(0.025)		(0.050)	
Weather Risk		-0.006		0.141**
		(0.032)		(0.067)
Disease Risk		0.052*		0.107*
		(0.028)		(0.056)
Economic Risk	0.022	0.024	-0.122	-0.166
	(0.066)	(0.066)	(0.183)	(0.186)
Idio Risk – Insurable	-0.016	-0.014	0.017	0.026
	(0.034)	(0.034)	(0.057)	(0.058)
Idio Risk – Not insured	-0.114	-0.119*	-0.150	-0.140
	(0.070)	(0.070)	(0.134)	(0.133)
Not Recovered (Prior)	0.018	0.012	-0.002	-0.003
	(0.029)	(0.030)	(0.054)	(0.055)
Natural Shocks	-0.032		-0.007	
	(0.025)		(0.049)	
Weather Shocks		-0.034		0.016
		(0.027)		(0.055)
Disease Shocks		0.023		0.045
		(0.026)		(0.052)
Economic Shocks	-0.041	-0.038	0.031	0.009
	(0.059)	(0.059)	(0.171)	(0.176)
Idio Shocks – Insurable	0.007	0.008	0.042	0.057
	(0.035)	(0.035)	(0.062)	(0.064)
Idio Shocks – Not insurable	-0.087	-0.089	-0.114	-0.108
	(0.056)	(0.057)	(0.117)	(0.117)
Not Recovered (Current)	-0.006	-0.019	-0.011	-0.030
	(0.027)	(0.027)	(0.050)	(0.051)
Natural Share Loss (Prior)	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.002)	(0.002)
Other Share Loss (Prior)	-0.018	-0.016	-0.057	-0.061
	(0.023)	(0.023)	(0.044)	(0.044)
Natural Share Loss (Current)	-0.042**	-0.043**	-0.053***	-0.053***
	(0.019)	(0.020)	(0.014)	(0.015)
Other Share Loss (Current)	-0.033*	-0.029	-0.075	-0.073
	(0.020)	(0.020)	(0.054)	(0.053)
Credit Indicator	-0.087***	-0.089***	-0.020	-0.020
	(0.022)	(0.022)	(0.041)	(0.041)
Formal Insurance Indicator	-0.059**	-0.058**	-0.073*	-0.073*
	(0.023)	(0.023)	(0.043)	(0.043)
External Transfer Indicator	-0.012	-0.015	-0.004	-0.006
	(0.021)	(0.021)	(0.043)	(0.044)
Wage Income (Log)	0.004	0.004	0.006	0.006
	(0.003)	(0.003)	(0.005)	(0.005)
Education	Yes	Yes	Yes	Yes
Household Size	-0.004	-0.003	-0.023	-0.024
	(0.015)	(0.015)	(0.029)	(0.029)
Age of Household Head	-0.004	-0.004	-0.003	-0.004
	(0.009)	(0.009)	(0.012)	(0.012)
Age Squared (HH Head)	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Time Dummies	Yes	Yes	Yes	Yes
Constant	0.036	0.025	0.053	0.063
	(0.219)	(0.217)	(0.334)	(0.335)
Observations	4025	4025	1319	1319
Number of HHid	2037	2037	675	675
R-squared	0.051	0.051	0.052	0.050

Robust standard errors are clustered at the household level and are given in parenthesis.
*** indicates significance at the 1% level, ** indicates significance at the 5% level, * indicates significance at the 10% level.

For the full sample (Column 1), we do not find any evidence that natural risk impacts on the share of liquid capital. Exploring the components of natural risk further however, reveals that

the presence of crop disease related risk increases the share of liquid savings in total investment by 5 per cent (Column 2). Results for the poorest households (Column 3) reveal that natural risk increases the growth rate of liquid capital by 13 per cent as theoretically predicted. This provides evidence that households engage in ex ante risk-induced saving which may also have a precautionary component.[85] Closer analysis of the type of natural risk reveals that while both weather and disease related risks are important, specific weather concerns appear to dominate disease related risks with households increasing their share of liquid asset holdings by 14 per cent for the former and 11 per cent for the latter (Column 4).

Noteworthy too is that the results for the full sample (Column 1), suggest that access to credit and formal insurance result in a reduction of household liquid asset share allocations by 9 per cent and 6 per cent respectively. This is suggestive of some complementarity between the financial 'trinity' of savings, credit and insurance instruments. The fact that credit is not significant for lower wealth households lends support to our existing evidence regarding the existence of credit constraints for the poor (Columns 3 and 4).

Overall, our results show that risk-induced trade-offs do exist for poorer households: households exposed to income risk experience a 17 per cent reduction in risky own-farm productive investment allocations which is offset by a 13 per cent increase in the share of non-productive precautionary savings. Further, there is weaker evidence to suggest that natural risk is an important determinant of investment in non-farm assets as a means of income diversification.[86]

3.5.4 Household Profitability

We now focus on estimates of household profitability to understand any consequences for total profit levels of the risk-induced household capital investment decisions identified above. We compute household profit measures as per Rosenzweig and Binswanger (1993) by subtracting from agricultural receipts all reported costs including the reported cost of labour used in production. Mean household profits recorded in 2010 are 24,365 ('000VND) with an average of 11,000 ('000 VND) for the poorest households. Approximately 28 per cent of all

[85] We cannot specifically disentangle a precautionary motive from that of diversification. However this ex ante result correlates with the corresponding ex post result evidenced by Wainwright and Newman (2011) who find that households deplete their stock of liquid savings in response to natural shocks.

[86] The primary results for covariate natural risk are also robust to 1) estimations using the level of liquid capital investment as the dependent variable and 2) estimations using the growth rate of liquid capital investment as the dependent variable.

households engage in some form of non-farm non-wage enterprise activities with 20 per cent of the poorest households earning income from this diversified source.

We estimate the profit function specified in equation (17) for total household profit and profit disaggregated by each type of activity. The results are presented in the Appendix 3.2 Table 3.2.4 which accompanies this chapter. The coefficients are used to compute average marginal effects of the change in each asset share on total household profit and its components relative to own farm capital which is chosen as the base investment category. The results are presented in Tables 3.7 for the full sample and for households in each wealth group.[87]

Table 3.7: Marginal Effects of Investment on Total Household Profit

	(1) Marginal Effect relative to Own-farm capital	(2) Marginal Effect relative to Own-farm capital Risk=0	(3) Marginal Effect relative to Own-farm capital Risk=1
		Full Sample	
Liquid Assets	-1.267***	-1.153***	-1.429***
	(0.029)	(0.042)	(0.045)
Non-farm Inv	-4.055***	-3.755***	-4.546***
	(0.048)	(0.065)	(0.074)
		Lowest Wealth Group	
Liquid Assets	-0.733***	-0.654***	-0.913***
	(0.066)	(0.088)	(0.113)
Non-farm Inv	-3.345***	-3.152***	-3.888***
	(0.090)	(0.119)	(0.160)
		Middle Wealth Group	
Liquid Assets	-1.414***	-1.244***	-1.542***
	(0.039)	(0.064)	(0.061)
Non-farm Inv	-4.593***	-4.316***	-4.943***
	(0.073)	(0.105)	(0.112)
		Highest Wealth Group	
Liquid Assets	-1.647***	-1.597***	-1.742***
	(0.033)	(0.050)	(0.053)
Non-farm Inv	-4.217***	-3.895***	-4.635***
	(0.077)	(0.103)	(0.124)

Bootstrapped standard errors clustered at the household level presented in parenthesis (Replications = 2,000, Observations = 6,132). *** indicates significance at 1% level, ** at 5% level and * at 10% level.

A negative *relative* marginal effect indicates that at the mean households are over-invested in that particular asset relative to own-farm capital while a positive *relative* marginal effect indicates that the household is under-invested in that particular asset. We are particularly interested in the extent to which this differs across risk categories and by wealth group.

[87] We include SME profit in the total household profit calculation as we have raw data on specific household revenues and costs from this source. We also consider that households use those assets not classified as own-farm or liquid as productive capital for non-farm activities. As discussed previously, due to data constraints we cannot state conclusively which assets were used precisely for which purposes.

Results indicate that all households in our sample fail to maximize profit (Column 1). This is evidenced from the negative average marginal effects indicating that households are over-invested in both liquid assets and non-farm capital relative to own-farm capital. These results are consistent across all wealth groups. Evidence against profit maximization is also consistent with incomplete markets although this study only explicitly considers incomplete insurance markets.

To examine now whether risk perceptions significantly influence total profit outcomes we compute average marginal effects for those households exposed to covariant risk (Column2) and those not exposed to covariant risk (Column 3). Results indicate that although each group of households fail to profit maximize, those with risk exposure are more over-invested in liquid assets and non-farm capital relative to own-farm capital. This result is also robust across wealth groups.

Overall, our results indicate that own-farm investment (relative to liquid assets and non-farm capital) falls short of profit maximizing levels for all households which is consistent with the presence of incomplete markets. More interesting is that those households exposed to risk (including the poorest households) suffer from increased under-investment in own-farm capital (compared with households not exposed to risk) and hence increased departures from profit maximizing levels of this higher-risk higher-return form of investment capital.

3.6 Conclusions

This paper contributes to Fafchamps (2010) call for more practical evidence on the effect of risk on behaviour in the form of household investment and savings decisions. Specifically, we have examined the extent to which exogenous covariant natural risk discourages households from ex ante investment in own-farm capital (for more risky farm production activities) while encouraging investment diversification in small enterprise capital (for less risky non-farm activities). Precautionary savings decisions were also empirically considered. In the absence of a distributional representation for forms of natural risk, we constructed a *risk proxy* for the natural risk facing each household using lagged realizations of natural risk recorded at the household level where we assume past experiences of natural shocks shape households' expectations regarding risk in the future.

Using panel data from rural Vietnam, our key result is that covariant natural risk acts as a deterrent to household investment in own-farm capital while encouraging non-farm non-productive investment diversification. This is consistent with our theoretical prediction and is most evident among the poorest households in our data. Our estimates of average marginal effects of investment categories on total profit show *over*-investment in liquid assets and non-farm capital relative to own-farm capital for all households. A corollary to this result is that households are *under*-invested in own-farm capital relative to profit maximizing levels. This result is also most pronounced for the poorest households facing covariant risk. Moreover, our empirical investigation uncovers additional mechanisms through which risk impacts on investment decisions that warrant further consideration. We find that idiosyncratic risk and not covariant risk encourages investment in non-farm non-productive diversification for wealthier households who have the means to make such investments. Risk is also found to motivate savings in forms of non-productive liquid capital for poorer households.

Taken together these results imply that natural risk, in the form of floods, droughts, and crop diseases, do matter for rural Vietnamese households' investment and savings decisions - particularly for the poorest. These results also show that a *mix* of income smoothing and consumption smoothing strategies are used. The fact that our results principally apply to households in the lowest wealth group lends support to the hypothesis that the poorest most credit constrained households are more likely to precautionary save and diversify their income streams as they are less willing/able to bear risk – even if they have the same intrinsic risk preferences as wealthier households.

In sum, we have provided at least some practical evidence that the mechanism established by Rosensweig and Binswanger (1993) remains relevant in developing country contexts. Our results also appeal to a behavioural motive for households by demonstrating that households are sensitive to recent income shocks. This implies that while it may be difficult in the short term to build up formal insurance mechanisms for the poorest farmers, our results highlight the continuing importance of risk reducing policies such as the provision of agricultural insurance and developing risk reducing technologies.

Appendix 3.1: Derivation of testable predictions for household investment shares

This appendix applies the solution methodology detailed in Ito and Kurosaki (2009) and provides a comparative static analysis of equations (10) through (12) which represent the optimal household capital allocations across own-farm, non-farm and liquid capital investments as corresponding shares of total household wealth.

We first approximate the first derivative of period two utility function $U'(.)$ within the first order conditions detailed in equation (8) (abstracting from the expectations operator for now) by applying a local Taylor approximation about current period household consumption (and dropping time subscripts) to obtain:[88]

$$U'(.) \approx$$
$$U'(C) + U''(\bar{C})(A + \tilde{\theta}_a\pi(A) + K + \tilde{\theta}_k\pi(K) + H + \tilde{\theta}_h\pi(H) - C) + {}^1/_2\, U'''(C)(A + \tilde{\theta}_a\pi(A) + K + \tilde{\theta}_k\pi(K) + H + \tilde{\theta}_h\pi(H) - C)^2 \quad \text{(A1)}$$

And with further manipulation (and keeping only second order terms) this expression becomes:

$$U'(.) \approx U'(C)\{1 - \alpha(W - C)\} \quad \text{(A2)}$$

Where $W = A + \tilde{\theta}_a\pi(A) + K + \tilde{\theta}_k\pi(K) + H + \tilde{\theta}_h\pi(H)$ represents household wealth in period two and where $\alpha = -\frac{U''}{U'}$ is the measure of absolute risk aversion. The assumptions detailed in the conceptual framework detailed in section 3.2 imply a variance covariance matrix of $\tilde{\theta}_k, \tilde{\theta}_h, \tilde{\theta}_a$ of the form:

$$\Sigma = \begin{pmatrix} \sigma_k^2 & \sigma_k\sigma_h\rho_{kh} & \sigma_k\sigma_a\rho_{ka} \\ \sigma_h\sigma_k\rho_{hk} & \sigma_h^2 & \sigma_h\sigma_a\rho_{ha} \\ \sigma_a\sigma_k\rho_{ak} & \sigma_a\sigma_h\rho_{ah} & \sigma_a^2 \end{pmatrix} \quad \text{(A3)}$$

[88] We also acknowledge the limitations of Taylor series approximations of expected utility as discussed by Hlawitschka (1994) who argues that their usefulness is strictly an empirical issue and unrelated to the properties of convergence of the infinite series. Here, we assume our theoretical analysis is locally stable and appeal more to the empirical predictions arising from our Taylor series expansion of expected utility rather than to the quality of the approximation itself.

where σ_j is the coefficient of variation of $\theta_j, j = k, h, a$, and where ρ_{kh}, ρ_{ka}, ρ_{ha} are the correlation coefficients. To motivate investment diversification we assume that $\rho_{kh} = -1$, $\rho_{ka} = \rho_{ha} = 0$. These demanding covariance assumptions are principally motivated by our empirical results on the effects of natural shocks on own-farm and non-farm ex post profitability. Further, we assume for ease of exposition that returns to liquid savings are not correlated with either own-farm or non-farm returns.We also assume that $\sigma_k^2 > \sigma_h^2 = \sigma_a^2$ to model a typical rural development context. With these assumptions the variance covariance becomes:

$$\Sigma = \begin{pmatrix} \sigma_k^2 & -\sigma_k\sigma_h & 0 \\ -\sigma_h\sigma_k & \sigma_h^2 & 0 \\ 0 & 0 & \sigma_a^2 \end{pmatrix} \tag{A4}$$

We next insert the covariance term detailed in (A3) together with the approximation from equation (A2) into the first order conditions detailed in equation (8) to obtain a system of equations upon which to base our comparative static analysis. Following Ito and Kurosaki (2009), we impose additional restrictions on the system by investigating the simplest case for which it is possible to obtain analytical results and under which is possible to understand the household mechanism through which changes to own-farm risk influences the underlying optimal capital share allocation decisions.

We represent each investment component as a share of total household net wealth (which is allocated in the previous period and is net of consumption) and we define net wealth as $\bar{W} = W - C$. Hence, a, k, and h represent the shares of net wealth $\bar{W}$ allocated to liquid savings, own-farm assets and non-farm assets respectively with total liquid savings $A = a\bar{W}$, total own-farm capital $K = k\bar{W}$ and total non-farm capital $H = h\bar{W}$. With each investment now represented as a share of household net wealth (allocated from period one), we therefore fix period one household wealth net of consumption to $\bar{W}$ to abstract from the inter-temporal consumption/savings decision.[89] We can therefore write period two wealth as:

$$W = A + \tilde{\theta}_a\pi(a\bar{W}) + K + \tilde{\theta}_k\pi(k\bar{W}) + H + \tilde{\theta}_h\pi(h\bar{W}) \tag{A5}$$

[89] Ito and Kurosaki (2009) similarly fix the total household labour supply at $\bar{L}$ thereby abstracting from the intra-temporal labour/leisure decision.

From which we can also write:

$$W = A + \tilde{\theta}_a \bar{W}\pi(a) + K + \tilde{\theta}_k \bar{W}\pi(k) + H + \tilde{\theta}_h \bar{W}\pi(h) \quad \text{(A6)}$$

More concretely, we begin by assuming that returns to own-farm, non-farm and liquid capital investments are linear and that their expected values (in equilibrium) are equalized at the risk free rate across own-farm and non-farm sectors together with returns to liquid savings. Hence we write that:[90]

$$\pi'(k\bar{W}) = \pi'(h\bar{W}) = \pi'(a\bar{W}) = r \quad \text{(A7)}$$

With this equilibrium simplification, together with our abstraction from the household inter-temporal consumption/savings decision, we assume that household total wealth in period two *including* profit returns becomes:

$$W = K + H + A + r\bar{W}\{k\tilde{\theta}_k + h\tilde{\theta}_h + (1 - k - h)\tilde{\theta}_a\} \quad \text{(A8)}$$

with K, H, A representing period two stocks of own-farm capital assets, non-farm capital assets and liquid capital respectively (all net of current depreciation). For simplicity we can assume that $\bar{W} = K + H + A$ from period one consumption/savings decision making. With these simplifications, equation (A2) now becomes:

$$U'(.) \approx U'(C)\{1 - \alpha(\bar{W} + r\bar{W}\{k\tilde{\theta}_k + h\tilde{\theta}_h + (1 - k - h)\tilde{\theta}_a\} - C)\} \quad \text{(A9)}$$

Inserting equation (A9) into equation (8) and rearranging, we obtain:

$$E[U'(.)\beta(1 + \tilde{\theta}_j r)] - E[U'(.)\beta(1 + \tilde{\theta}_a r)] = 0,\ j = k, h$$

which becomes:

[90] Ito and Kurosaki (2009) similarly set equilibrium returns to labour allocations equal to the wage rate w.

$$E\big[U'(C)\{1-\alpha(\bar{W}+r\bar{W}\{k\tilde{\theta}_k+h\tilde{\theta}_h+(1-k-h)\tilde{\theta}_a\}-C)\}\beta(1+\tilde{\theta}_j r)\big]$$
$$-E\big[U'(\bar{W})\{1-\alpha(\bar{W}+r\bar{W}\{k\tilde{\theta}_k+h\tilde{\theta}_h+(1-k-h)\tilde{\theta}_a\}-C)\}\beta(1$$
$$+\tilde{\theta}_a r)\big]=0, \qquad j=k,h$$

and which reduces to:

$$E\big[U'(C)\{1-\alpha(\bar{W}+r\bar{W}\{k\tilde{\theta}_k+h\tilde{\theta}_h+(1-k-h)\tilde{\theta}_a\}-C)\}\beta(\tilde{\theta}_j-\tilde{\theta}_a)\big]=0,\ j=k,h \tag{A10}$$

Specifically, expanding for the own-farm capital share k becomes:

$$E\big[U'(C)\{1-\alpha(\bar{W}+r\bar{W}\{k\tilde{\theta}_k+h\tilde{\theta}_h+(1-k-h)\tilde{\theta}_a\}-\bar{W})\}\beta(\tilde{\theta}_k-\tilde{\theta}_a)\big]=0 \tag{A11}$$

And expanding for the non-farm capital share h becomes:

$$E\big[U'(C)\{1-\alpha(\bar{W}+r\bar{W}\{k\tilde{\theta}_k+h\tilde{\theta}_h+(1-k-h)\tilde{\theta}_a\}-C)\}\beta(\tilde{\theta}_h-\tilde{\theta}_a)\big]=0 \tag{A12}$$

We first expand (A11) for own-farm capital share k in discrete steps:

$$E\big[U'(C)\{1-\alpha(\bar{W}+r\bar{W}\{k\tilde{\theta}_k+h\tilde{\theta}_h+(1-k-h)\tilde{\theta}_a\}-C)\}\beta(\tilde{\theta}_k-\tilde{\theta}_a)\big]=0$$

Which, eliminating $U'(.),\beta$ (assuming independence) gives:

$$E\big[\{1-\alpha(\bar{W}+r\bar{W}\{k\tilde{\theta}_k+h\tilde{\theta}_h+(1-k-h)\tilde{\theta}_a\}-C)\}(\tilde{\theta}_k-\tilde{\theta}_a)\big]=0$$

Which, expanding the inner most bracket gives:

$$E\big[\{1-\alpha(\bar{W}+r\bar{W}\{k\tilde{\theta}_k+h\tilde{\theta}_h+\tilde{\theta}_a-\tilde{\theta}_a k-\tilde{\theta}_a h\}-C)\}(\tilde{\theta}_k-\tilde{\theta}_a)\big]=0$$

Which, expanding the next bracket gives:

$$E\big[\{1-\alpha(\bar{W}+r\bar{W}k\tilde{\theta}_k+r\bar{W}h\tilde{\theta}_h+r\bar{W}\tilde{\theta}_a-r\bar{W}\tilde{\theta}_a k-r\bar{W}\tilde{\theta}_a h-C)\}(\tilde{\theta}_k-\tilde{\theta}_a)\big]=0$$

Which, expanding the next bracket gives:

$$E\big[\{1-\alpha\bar{W}-\alpha r\bar{W}k\tilde{\theta}_k-\alpha r\bar{W}h\tilde{\theta}_h-\alpha r\bar{W}\tilde{\theta}_a+\alpha r\bar{W}\tilde{\theta}_a k+\alpha r\bar{W}\tilde{\theta}_a h+\alpha C\}(\tilde{\theta}_k-\tilde{\theta}_a)\big]$$
$$=0$$

Which, expanding the final bracket gives:

$$E\left[\{\tilde{\theta}_k - \alpha\bar{W}\tilde{\theta}_k - \alpha r\bar{W}k\tilde{\theta}_k\tilde{\theta}_k - \alpha r\bar{W}h\tilde{\theta}_h\tilde{\theta}_k - \alpha r\bar{W}\tilde{\theta}_a\tilde{\theta}_k + \alpha r\bar{W}\tilde{\theta}_a k\tilde{\theta}_k + \alpha r\bar{W}\tilde{\theta}_a h\tilde{\theta}_k + \alpha C\tilde{\theta}_k - \tilde{\theta}_a + \alpha\bar{W}\tilde{\theta}_a + \alpha r\bar{W}k\tilde{\theta}_k\tilde{\theta}_a + \alpha r\bar{W}h\tilde{\theta}_h\tilde{\theta}_a + \alpha r\bar{W}\tilde{\theta}_a\tilde{\theta}_a - \alpha r\bar{W}\tilde{\theta}_a k\tilde{\theta}_a - \alpha r\bar{W}\tilde{\theta}_a h\tilde{\theta}_a - \alpha C\tilde{\theta}_a\}\right] = 0$$

Which, simplifying gives:

$$E\left[\{\tilde{\theta}_k - \alpha\bar{W}\tilde{\theta}_k - \alpha r\bar{W}k\tilde{\theta}_k\tilde{\theta}_k - \alpha r\bar{W}h\tilde{\theta}_h\tilde{\theta}_k - \alpha r\bar{W}\tilde{\theta}_a\tilde{\theta}_k + 2\alpha r\bar{W}\tilde{\theta}_a k\tilde{\theta}_k + \alpha r\bar{W}\tilde{\theta}_a h\tilde{\theta}_k + \alpha C\tilde{\theta}_k - \tilde{\theta}_a + \alpha\bar{W}\tilde{\theta}_a + \alpha r\bar{W}h\tilde{\theta}_h\tilde{\theta}_a + \alpha r\bar{W}\tilde{\theta}_a\tilde{\theta}_a - \alpha r\bar{W}\tilde{\theta}_a k\tilde{\theta}_a - \alpha r\bar{W}\tilde{\theta}_a h\tilde{\theta}_a - \alpha C\tilde{\theta}_a\}\right] = 0$$

Now, expanding across the expectations operator gives:

$$E[\tilde{\theta}_k] - E[\alpha\bar{W}\tilde{\theta}_k] - E[\alpha r\bar{W}k\tilde{\theta}_k\tilde{\theta}_k] - E[\alpha r\bar{W}h\tilde{\theta}_h\tilde{\theta}_k] - E[\alpha r\bar{W}\tilde{\theta}_a\tilde{\theta}_k] + E[2\alpha r\bar{W}\tilde{\theta}_a k\tilde{\theta}_k] + E[\alpha r\bar{W}\tilde{\theta}_a h\tilde{\theta}_k] + E[\alpha C\tilde{\theta}_k] - E[\tilde{\theta}_a] + E[\alpha\bar{W}\tilde{\theta}_a] + E[\alpha r\bar{W}h\tilde{\theta}_h\tilde{\theta}_a] + E[\alpha r\bar{W}\tilde{\theta}_a\tilde{\theta}_a] - E[\alpha r\bar{W}\tilde{\theta}_a k\tilde{\theta}_a] - E[\alpha r\bar{W}\tilde{\theta}_a h\tilde{\theta}_a] - E[\alpha C\tilde{\theta}_a] = 0$$

Removing constants outside the brackets gives:

$$E[\tilde{\theta}_k] - E[\tilde{\theta}_k]\alpha\bar{W} - E[\tilde{\theta}_k\tilde{\theta}_k]\alpha r\bar{W}k - E[\tilde{\theta}_h\tilde{\theta}_k]\alpha r\bar{W}h - E[\tilde{\theta}_a\tilde{\theta}_k]\alpha r\bar{W} + E[\tilde{\theta}_a\tilde{\theta}_k]2\alpha r\bar{W}k + E[\tilde{\theta}_a\tilde{\theta}_k]\alpha r\bar{W}h + E[\tilde{\theta}_k]\alpha C - E[\tilde{\theta}_a] + E[\tilde{\theta}_a]\alpha\bar{W} + E[\tilde{\theta}_h\tilde{\theta}_a]\alpha r\bar{W}h + E[\tilde{\theta}_a\tilde{\theta}_a]\alpha r\bar{W} - E[\tilde{\theta}_a\tilde{\theta}_a]\alpha r\bar{W}k - E[\tilde{\theta}_a\tilde{\theta}_a]\alpha r\bar{W}h - E[\tilde{\theta}_a]\alpha C = 0$$

Evaluating the expectations operator and inserting (A4) gives:

$$1 - \alpha\bar{W} - (\sigma_k^2 + 1)\alpha r\bar{W}k - (\sigma_k\sigma_h\rho_{kh} + 1)\alpha r\bar{W}h - (\sigma_k\sigma_a\rho_{ka} + 1)\alpha r\bar{W} + (\sigma_k\sigma_a\rho_{ka} + 1)2\alpha r\bar{W}k + (\sigma_k\sigma_a\rho_{ka} + 1)\alpha r\bar{W}h + \alpha C - 1 + \alpha\bar{W} + (\sigma_h\sigma_a\rho_{ha} + 1)\alpha r\bar{W}h + (\sigma_a^2 + 1)\alpha r\bar{W} - (\sigma_a^2 + 1)\alpha r\bar{W}k - (\sigma_a^2 + 1)\alpha r\bar{W}h - \alpha C = 0$$

Expanding the terms in the brackets end eliminating simple terms gives:

$$-\alpha\bar{W} - \sigma_k^2\alpha r\bar{W}k - \alpha r\bar{W}k - \sigma_k\sigma_h\rho_{kh}\alpha r\bar{W}h - \alpha r\bar{W}h - \sigma_k\sigma_a\rho_{ka}\alpha r\bar{W} - \alpha r\bar{W} + \sigma_k\sigma_a\rho_{ka}2\alpha r\bar{W}k + 2\alpha r\bar{W}k + \sigma_k\sigma_a\rho_{ka}\alpha r\bar{W}h + \alpha r\bar{W}h + \alpha\bar{W} + \sigma_h\sigma_a\rho_{ha}\alpha r\bar{W}h + \alpha r\bar{W}h + \sigma_a^2\alpha r\bar{W} + \alpha r\bar{W} - \sigma_a^2\alpha r\bar{W}k - \alpha r\bar{W}k - \sigma_a^2\alpha r\bar{W}h - \alpha r\bar{W}h = 0$$

Gathering terms of k and h on the left hand side gives:

$$-\sigma_k^2 \alpha r\bar{W}k - \alpha r\bar{W}k - \sigma_k\sigma_h\rho_{kh}\alpha r\bar{W}h - \alpha r\bar{W}h + \sigma_k\sigma_a\rho_{ka}2\alpha r\bar{W}k + 2\alpha r\bar{W}k$$
$$+ \sigma_k\sigma_a\rho_{ka}\alpha r\bar{W}h + \alpha r\bar{W}h + \sigma_h\sigma_a\rho_{ha}\alpha r\bar{W}h + \alpha r\bar{W}h - \sigma_a^2\alpha r\bar{W}k - \alpha r\bar{W}k$$
$$- \sigma_a^2\alpha r\bar{W}h - \alpha r\bar{W}h$$
$$= \alpha\bar{W} + \sigma_k\sigma_a\rho_{ka}\alpha r\bar{W} + \alpha r\bar{W} - \alpha\bar{W} - \sigma_a^2\alpha r\bar{W} - \alpha r\bar{W}$$

Which equates to:

$$k(\sigma_k\sigma_a\rho_{ka}2\alpha r\bar{W} - \sigma_k^2\alpha r\bar{W} - \alpha r\bar{W} + 2\alpha r\bar{W} - \sigma_a^2\alpha r\bar{W} - \alpha r\bar{W}) + h(-\sigma_k\sigma_h\rho_{kh}\alpha r\bar{W}$$
$$- \alpha r\bar{W} + \sigma_k\sigma_a\rho_{ka}\alpha r\bar{W} + \alpha r\bar{W} + \sigma_h\sigma_a\rho_{ha}\alpha r\bar{W} + \alpha r\bar{W} - \sigma_a^2\alpha r\bar{W} - \alpha r\bar{W})$$
$$= \alpha\bar{W} + \sigma_k\sigma_a\rho_{ka}\alpha r\bar{W} + \alpha r\bar{W} - \alpha\bar{W} - \sigma_a^2\alpha r\bar{W} - \alpha r\bar{W}$$

Which eliminating terms gives:

$$k(\sigma_k\sigma_a\rho_{ka}2\alpha r\bar{W} - \sigma_k^2\alpha r\bar{W} - \sigma_a^2\alpha r\bar{W}) + h(-\sigma_k\sigma_h\rho_{kh}\alpha r\bar{W} + \sigma_k\sigma_a\rho_{ka}\alpha r\bar{W} +$$
$$\sigma_h\sigma_a\rho_{ha}\alpha r\bar{W} - \sigma_a^2\alpha r\bar{W}) = \sigma_k\sigma_a\rho_{ka}\alpha r\bar{W} - \sigma_a^2\alpha r\bar{W}$$

(A13)

We next expand (A12) for non-farm capital share h in discrete steps:

$$E\left[U'(C)\left\{1 - \alpha(\bar{W} + r\bar{W}\left\{k\tilde{\theta}_k + h\tilde{\theta}_h + (1-k-h)\tilde{\theta}_a\right\} - C)\right\}\beta\left(\tilde{\theta}_h - \tilde{\theta}_a\right)\right] = 0$$

Which, eliminating $U'(.), \beta$ gives:

$$E\left[\left\{1 - \alpha(\bar{W} + r\bar{W}\left\{k\tilde{\theta}_k + h\tilde{\theta}_h + (1-k-h)\tilde{\theta}_a\right\} - C)\right\}\left(\tilde{\theta}_h - \tilde{\theta}_a\right)\right] = 0$$

Which, expanding the inner most bracket gives:

$$E\left[\left\{1 - \alpha(\bar{W} + r\bar{W}\left\{k\tilde{\theta}_k + h\tilde{\theta}_h + \tilde{\theta}_a - \tilde{\theta}_a k - \tilde{\theta}_a h\right\} - C)\right\}\left(\tilde{\theta}_h - \tilde{\theta}_a\right)\right] = 0$$

Which, expanding the next bracket gives:

$$E\left[\left\{1 - \alpha(\bar{W} + r\bar{W}k\tilde{\theta}_k + r\bar{W}h\tilde{\theta}_h + r\bar{W}\tilde{\theta}_a - r\bar{W}\tilde{\theta}_a k - r\bar{W}\tilde{\theta}_a h - C)\right\}\left(\tilde{\theta}_h - \tilde{\theta}_a\right)\right] = 0$$

Which, expanding the next bracket gives:

$$E\left[\left\{1 - \alpha\bar{W} - \alpha r\bar{W}k\tilde{\theta}_k - \alpha r\bar{W}h\tilde{\theta}_h - \alpha r\bar{W}\tilde{\theta}_a + \alpha r\bar{W}\tilde{\theta}_a k + \alpha r\bar{W}\tilde{\theta}_a h + \alpha C\right\}\left(\tilde{\theta}_h - \tilde{\theta}_a\right)\right]$$
$$= 0$$

Which, expanding the final bracket gives:

$$E\left[\{\tilde{\theta}_h - \alpha\bar{W}\tilde{\theta}_h - \alpha r\bar{W}k\tilde{\theta}_k\tilde{\theta}_h - \alpha r\bar{W}h\tilde{\theta}_h\tilde{\theta}_h - \alpha r\bar{W}\tilde{\theta}_a\tilde{\theta}_h + \alpha r\bar{W}\tilde{\theta}_a k\tilde{\theta}_h + \alpha r\bar{W}\tilde{\theta}_a h\tilde{\theta}_h + \alpha C\tilde{\theta}_h - \tilde{\theta}_a + \alpha\bar{W}\tilde{\theta}_a + \alpha r\bar{W}k\tilde{\theta}_k\tilde{\theta}_a + \alpha r\bar{W}h\tilde{\theta}_h\tilde{\theta}_a + \alpha r\bar{W}\tilde{\theta}_a\tilde{\theta}_a - \alpha r\bar{W}\tilde{\theta}_a k\tilde{\theta}_a - \alpha r\bar{W}\tilde{\theta}_a h\tilde{\theta}_a - \alpha C\tilde{\theta}_a\}\right] = 0$$

Which, simplifying gives:

$$E\left[\{\tilde{\theta}_h - \alpha\bar{W}\tilde{\theta}_h - \alpha r\bar{W}k\tilde{\theta}_k\tilde{\theta}_h - \alpha r\bar{W}h\tilde{\theta}_h\tilde{\theta}_h - \alpha r\bar{W}\tilde{\theta}_a\tilde{\theta}_h + \alpha r\bar{W}\tilde{\theta}_a k\tilde{\theta}_h + 2\alpha r\bar{W}\tilde{\theta}_a h\tilde{\theta}_h + \alpha C\tilde{\theta}_h - \tilde{\theta}_a + \alpha\bar{W}\tilde{\theta}_a + \alpha r\bar{W}k\tilde{\theta}_k\tilde{\theta}_a + \alpha r\bar{W}\tilde{\theta}_a\tilde{\theta}_a - \alpha r\bar{W}\tilde{\theta}_a k\tilde{\theta}_a - \alpha r\bar{W}\tilde{\theta}_a h\tilde{\theta}_a - \alpha C\tilde{\theta}_a\}\right] = 0$$

Now, expanding across the expectations operator gives:

$$E[\tilde{\theta}_h] - E[\alpha\bar{W}\tilde{\theta}_h] - E[\alpha r\bar{W}k\tilde{\theta}_k\tilde{\theta}_h] - E[\alpha r\bar{W}h\tilde{\theta}_h\tilde{\theta}_h] - E[\alpha r\bar{W}\tilde{\theta}_a\tilde{\theta}_h] + E[\alpha r\bar{W}\tilde{\theta}_a k\tilde{\theta}_h] + E[2\alpha r\bar{W}\tilde{\theta}_a h\tilde{\theta}_h] + E[\alpha C\tilde{\theta}_h] - E[\tilde{\theta}_a] + E[\alpha\bar{W}\tilde{\theta}_a] + E[\alpha r\bar{W}k\tilde{\theta}_k\tilde{\theta}_a] - E[\alpha r\bar{W}\tilde{\theta}_a\tilde{\theta}_a] - E[\alpha r\bar{W}\tilde{\theta}_a k\tilde{\theta}_a] - E[\alpha r\bar{W}\tilde{\theta}_a h\tilde{\theta}_a] - E[\alpha C\tilde{\theta}_a] = 0$$

Removing constants outside the brackets gives:

$$E[\tilde{\theta}_h] - E[\tilde{\theta}_h]\alpha\bar{W} - E[\tilde{\theta}_k\tilde{\theta}_h]\alpha r\bar{W}k - E[\tilde{\theta}_h\tilde{\theta}_h]\alpha r\bar{W}h - E[\tilde{\theta}_a\tilde{\theta}_h]\alpha r\bar{W} + E[\tilde{\theta}_a\tilde{\theta}_h]\alpha r\bar{W}k + E[\tilde{\theta}_a\tilde{\theta}_h]2\alpha r\bar{W}h + E[\tilde{\theta}_h]\alpha C - E[\tilde{\theta}_a] + E[\tilde{\theta}_a]\alpha\bar{W} + E[\tilde{\theta}_k\tilde{\theta}_a]\alpha r\bar{W}k - E[\tilde{\theta}_a\tilde{\theta}_a]\alpha r\bar{W} - E[\tilde{\theta}_a\tilde{\theta}_a]\alpha r\bar{W}k - E[\tilde{\theta}_a\tilde{\theta}_a]\alpha r\bar{W}h - E[\tilde{\theta}_a]\alpha C = 0$$

Evaluating the expectations operator and inserting (A4) gives:

$$1 - \alpha\bar{W} - (\sigma_k\sigma_h\rho_{kh} + 1)\alpha r\bar{W}k - (\sigma_h^2 + 1)\alpha r\bar{W}h - (\sigma_h\sigma_a\rho_{ha} + 1)\alpha r\bar{W} + (\sigma_h\sigma_a\rho_{ha} + 1)\alpha r\bar{W}k + (\sigma_h\sigma_a\rho_{ha} + 1)2\alpha r\bar{W}h + \alpha C - 1 + \alpha\bar{W} + (\sigma_k\sigma_a\rho_{ka} + 1)\alpha r\bar{W}k - (\sigma_a^2 + 1)\alpha r\bar{W} - (\sigma_a^2 + 1)\alpha r\bar{W}k - (\sigma_a^2 + 1)\alpha r\bar{W}h - \alpha C = 0$$

Expanding the terms in the brackets end eliminating simple terms gives:

$$-\alpha\bar{W} - \sigma_k\sigma_h\rho_{kh}\alpha r\bar{W}k - \alpha r\bar{W}k - \sigma_h^2\alpha r\bar{W}h - \alpha r\bar{W}h - \sigma_h\sigma_a\rho_{ha}\alpha r\bar{W} - \alpha r\bar{W} + \sigma_h\sigma_a\rho_{ha}\alpha r\bar{W}k + \alpha r\bar{W}k + \sigma_h\sigma_a\rho_{ha}2\alpha r\bar{W}h + 2\alpha r\bar{W}h + \alpha\bar{W} + \sigma_k\sigma_a\rho_{ka}\alpha r\bar{W}k + \alpha r\bar{W}k - \sigma_a^2\alpha r\bar{W} - \alpha r\bar{W} - \sigma_a^2\alpha r\bar{W}k - \alpha r\bar{W}k - \sigma_a^2\alpha r\bar{W}h - \alpha r\bar{W}h = 0$$

Gathering terms of k and h on the left hand side gives:

$$-\sigma_k\sigma_h\rho_{kh}\alpha r\bar{W}k - \alpha r\bar{W}k - \sigma_h^2\alpha r\bar{W}h - \alpha r\bar{W}h + \sigma_h\sigma_a\rho_{ha}\alpha r\bar{W}k + \alpha r\bar{W}k$$
$$+ \sigma_h\sigma_a\rho_{ha}2\alpha r\bar{W}h + 2\alpha r\bar{W}h + \sigma_k\sigma_a\rho_{ka}\alpha r\bar{W}k + \alpha r\bar{W}k - \sigma_a^2\alpha r\bar{W}k$$
$$- \alpha r\bar{W}k - \sigma_a^2\alpha r\bar{W}h - \alpha r\bar{W}h$$
$$= \alpha\bar{W} + \alpha r\bar{W} - \alpha\bar{W} + \sigma_a^2\alpha r\bar{W} + \alpha r\bar{W} + \sigma_h\sigma_a\rho_{ha}\alpha r\bar{W}$$

Which equates to:

$$k(-\sigma_k\sigma_h\rho_{kh}\alpha r\bar{W} - \alpha r\bar{W} + \sigma_h\sigma_a\rho_{ha}\alpha r\bar{W} + \alpha r\bar{W} + \sigma_k\sigma_a\rho_{ka}\alpha r\bar{W} + \alpha r\bar{W} - \sigma_a^2\alpha r\bar{W}$$
$$- \alpha r\bar{W}) + h(-\sigma_h^2\alpha r\bar{W} - \alpha r\bar{W} + \sigma_h\sigma_a\rho_{ha}2\alpha r\bar{W} + 2\alpha r\bar{W} - \sigma_a^2\alpha r\bar{W}$$
$$- \alpha r\bar{W}) = \alpha\bar{W} + \alpha r\bar{W} - \alpha\bar{W} + \sigma_a^2\alpha r\bar{W} + \alpha r\bar{W} + \sigma_h\sigma_a\rho_{ha}\alpha r\bar{W}$$

Which eliminating terms gives:

$$k(-\sigma_k\sigma_h\rho_{kh}\alpha r\bar{W} + \sigma_h\sigma_a\rho_{ha}\alpha r\bar{W} + \sigma_k\sigma_a\rho_{ka}\alpha r\bar{W} - 2\sigma_a^2\alpha r\bar{W}) + h(\sigma_h\sigma_a\rho_{ha}2\alpha r\bar{W} -$$
$$\sigma_h^2\alpha r\bar{W}) = 2\alpha r\bar{W} + \sigma_a^2\alpha r\bar{W} + \sigma_h\sigma_a\rho_{ha}\alpha r\bar{W}$$

(A14)

Rewriting (A13) and (A14) respectively for ease of illustration:

$$k\Sigma_{11} + h\Sigma_{12} = \sigma_k\sigma_a\rho_{ka}\alpha r\bar{W} - \sigma_a^2\alpha r\bar{W} \quad \text{(A15)}$$

and

$$k\Sigma_{21} + h\Sigma_{22} = 2\alpha r\bar{W} + \sigma_a^2\alpha r\bar{W} + \sigma_h\sigma_a\rho_{ha}\alpha r\bar{W} \quad \text{(A16)}$$

where

$$\Sigma_{11} = \sigma_k\sigma_a\rho_{ka}2\alpha r\bar{W} - \sigma_k^2\alpha r\bar{W} - \sigma_a^2\alpha r\bar{W}$$
$$\Sigma_{12} = -\sigma_k\sigma_h\rho_{kh}\alpha r\bar{W} + \sigma_k\sigma_a\rho_{ka}\alpha r\bar{W} + \sigma_h\sigma_a\rho_{ha}\alpha r\bar{W} - \sigma_a^2\alpha r\bar{W}$$
$$\Sigma_{21} = -\sigma_k\sigma_h\rho_{kh}\alpha r\bar{W} + \sigma_h\sigma_a\rho_{ha}\alpha r\bar{W} + \sigma_k\sigma_a\rho_{ka}\alpha r\bar{W} - 2\sigma_a^2\alpha r\bar{W}$$
$$\Sigma_{22} = \sigma_h\sigma_a\rho_{ha}2\alpha r\bar{W} - \sigma_h^2\alpha r\bar{W}$$

Now writing (A15) and (A16) in matrix form gives:

$$\begin{pmatrix}\Sigma_{11} & \Sigma_{12}\\ \Sigma_{21} & \Sigma_{22}\end{pmatrix}\begin{pmatrix}k\\ h\end{pmatrix} = \begin{pmatrix}\sigma_k\sigma_a\rho_{ka}\alpha r\bar{W} - \sigma_a^2\alpha r\bar{W}\\ 2\alpha r\bar{W} + \sigma_a^2\alpha r\bar{W} + \sigma_h\sigma_a\rho_{ha}\alpha r\bar{W}\end{pmatrix} \quad \text{(A17)}$$

where this system can be solved by finding a closed form solution. For ease of illustration we let D denote the determinant of the two-by-two matrix above where

$$D = (\Sigma_{11}\Sigma_{22}) - (\Sigma_{12}\Sigma_{21})$$

and where:

$$\binom{k}{h} = \frac{1}{D}\begin{pmatrix} \Sigma_{22} & -\Sigma_{12} \\ -\Sigma_{21} & \Sigma_{11} \end{pmatrix}\begin{pmatrix} \sigma_k\sigma_a\rho_{ka}\alpha r\bar{W} - \sigma_a^2\alpha r\bar{W} \\ 2\alpha r\bar{W} + \sigma_a^2\alpha r\bar{W} + \sigma_h\sigma_a\rho_{ha}\alpha r\bar{W} \end{pmatrix} \quad \text{(A18)}$$

With own-farm capital investment share:

$$k = \frac{1}{D}(\Sigma_{22}(\sigma_k\sigma_a\rho_{ka}\alpha r\bar{W} - \sigma_a^2\alpha r\bar{W}) - \Sigma_{12}(2\alpha r\bar{W} + \sigma_a^2\alpha r\bar{W} + \sigma_h\sigma_a\rho_{ha}\alpha r\bar{W}))$$

(A19)

And non-farm capital investment share:

$$h = -\frac{1}{D}(\Sigma_{21}(\sigma_k\sigma_a\rho_{ka}\alpha r\bar{W} - \sigma_a^2\alpha r\bar{W}) + \Sigma_{11}(2\alpha r\bar{W} + \sigma_a^2\alpha r\bar{W} + \sigma_h\sigma_a\rho_{ha}\alpha r\bar{W})) \quad \text{(A20)}$$

and liquid capital investment share:

$$a = 1 - k - h \quad \text{(A21)}$$

Now, in order to evaluate the direction of responsiveness of optimal own-farm capital to an increase in own farm risk $\frac{\partial k}{\partial \sigma_k}$ we construct the following comparative static relationship by expanding our expression for k whereby:

$$k = \frac{1}{D}((\sigma_h\sigma_a\rho_{ha}2\alpha r\bar{W} - \sigma_h^2\alpha r\bar{W})(\sigma_k\sigma_a\rho_{ka}\alpha r\bar{W} - \sigma_a^2\alpha r\bar{W}) - (-\sigma_k\sigma_h\rho_{kh}\alpha r\bar{W} + \sigma_k\sigma_a\rho_{ka}\alpha r\bar{W} + \sigma_h\sigma_a\rho_{ha}\alpha r\bar{W} - \sigma_a^2\alpha r\bar{W})(2\alpha r\bar{W} + \sigma_a^2\alpha r\bar{W} + \sigma_h\sigma_a\rho_{ha}\alpha r\bar{W}))$$

(A22)

To determine the sign of $\frac{\partial k}{\partial \sigma_k}$, in the most tractable manner, we apply our rural Vietnamese contextual assumptions concerning the main risk parameters as follows as outlined in (A4) above:

Evaluating the expression for k:

$$k = \frac{1}{D}((-\sigma_h^2\alpha r\bar{W})(-\sigma_a^2\alpha r\bar{W}) - (\sigma_k\sigma_h\alpha r\bar{W} - \sigma_a^2\alpha r\bar{W})(2\alpha r\bar{W} + \sigma_a^2\alpha r\bar{W}))$$

Multiplying out gives:

$$k = \frac{1}{D}((\sigma_h^2\sigma_a^2(\alpha r\bar{W})^2) - (2\alpha r\bar{W}(\sigma_k\sigma_h\alpha r\bar{W}) - 2\alpha r\bar{W}(\sigma_a^2\alpha r\bar{W}) + \sigma_a^2\alpha r\bar{W}(\sigma_k\sigma_h\alpha r\bar{W}) - \sigma_a^2\alpha r\bar{W}(\sigma_a^2\alpha r\bar{W})))$$

Removing brackets gives:

$$k = \frac{1}{D}(\sigma_h^2\sigma_a^2(\alpha r\bar{W})^2 - 2\alpha r\bar{W}(\sigma_k\sigma_h\alpha r\bar{W}) + 2\alpha r\bar{W}(\sigma_a^2\alpha r\bar{W}) - \sigma_a^2\alpha r\bar{W}(\sigma_k\sigma_h\alpha r\bar{W}) + \sigma_a^2\alpha r\bar{W}(\sigma_a^2\alpha r\bar{W}))$$

And simplifying gives:

$$k = \frac{1}{D}(\sigma_h^2\sigma_a^2(\alpha r\bar{W})^2 - 2\alpha r\bar{W}(\sigma_k\sigma_h\alpha r\bar{W}) + 2\alpha r\bar{W}(\sigma_a^2\alpha r\bar{W}) - \sigma_a^2\alpha r\bar{W}(\sigma_k\sigma_h\alpha r\bar{W}) + (\sigma_a^2\alpha r\bar{W})^2)$$

Now, evaluating the determinant D:

$$D = (\sigma_k\sigma_a\rho_{ka}2\alpha r\bar{W} - \sigma_k^2\alpha r\bar{W} - \sigma_a^2\alpha r\bar{W})(\sigma_h\sigma_a\rho_{ha}2\alpha r\bar{W} - \sigma_h^2\alpha r\bar{W}) - (-\sigma_k\sigma_h\rho_{kh}\alpha r\bar{W} +$$

$\sigma_k\sigma_a\rho_{ka}\alpha r\bar{W} + \sigma_h\sigma_a\rho_{ha}\alpha r\bar{W} - \sigma_a^2\alpha r\bar{W})(-\sigma_k\sigma_h\rho_{kh}\alpha r\bar{W} + \sigma_h\sigma_a\rho_{ha}\alpha r\bar{W} +$
$\sigma_k\sigma_a\rho_{ka}\alpha r\bar{W} - 2\sigma_a^2\alpha r\bar{W})$

Applying the contextual assumptions from (A4):

$D = (-\sigma_k^2\alpha r\bar{W} - \sigma_a^2\alpha r\bar{W})(-\sigma_h^2\alpha r\bar{W}) - (\sigma_k\sigma_h\alpha r\bar{W} - \sigma_a^2\alpha r\bar{W})(-\sigma_k\sigma_h\alpha r\bar{W} - 2\sigma_a^2\alpha r\bar{W})$

Multiplying out gives:

$D =$
$\sigma_k^2\sigma_h^2(\alpha r\bar{W})^2 + \sigma_k^2\sigma_a^2(\alpha r\bar{W})^2 + (\sigma_k\sigma_h\alpha r\bar{W})^2 - \sigma_k\sigma_h\alpha r\bar{W}(\sigma_a^2\alpha r\bar{W}) +$
$2\sigma_a^2\alpha r\bar{W}(\sigma_k\sigma_h\alpha r\bar{W}) - 2\sigma_a^2\alpha r\bar{W}(\sigma_a^2\alpha r\bar{W})$

Applying the determinant gives:

$$k = (\sigma_k^2\sigma_h^2(\alpha r\bar{W})^2 + \sigma_k^2\sigma_a^2(\alpha r\bar{W})^2 + (\sigma_k\sigma_h\alpha r\bar{W})^2 - \sigma_k\sigma_h\alpha r\bar{W}(\sigma_a^2\alpha r\bar{W}) + 2\sigma_a^2\alpha r\bar{W}(\sigma_k\sigma_h\alpha r\bar{W}) - 2\sigma_a^2\alpha r\bar{W}(\sigma_a^2\alpha r\bar{W}))^{-1}[\sigma_h^2\sigma_a^2(\alpha r\bar{W})^2 - 2\alpha r\bar{W}(\sigma_k\sigma_h\alpha r\bar{W}) + 2\alpha r\bar{W}(\sigma_a^2\alpha r\bar{W}) - \sigma_a^2\alpha r\bar{W}(\sigma_k\sigma_h\alpha r\bar{W}) + (\sigma_a^2\alpha r\bar{W})^2]$$

Letting $\alpha r\bar{W} = C$, a positive constant:

$$k = (\sigma_k^2\sigma_h^2(C)^2 + \sigma_k^2\sigma_a^2(C)^2 + (\sigma_k\sigma_h C)^2 - \sigma_k\sigma_h(\sigma_a^2)(C)^2 + 2\sigma_a^2C(\sigma_k\sigma_h C) - 2\sigma_a^2C(\sigma_a^2C))^{-1}[\sigma_h^2\sigma_a^2(C)^2 - 2C(\sigma_k\sigma_h C) + 2C(\sigma_a^2C) - \sigma_a^2C(\sigma_k\sigma_h C) + (\sigma_a^2C)^2]$$

Determining $\frac{\partial k}{\partial \sigma_k}$ gives by the product rule gives:

$$\frac{\partial k}{\partial \sigma_k} = (\sigma_k^2\sigma_h^2(C)^2 + \sigma_k^2\sigma_a^2(C)^2 + (\sigma_k\sigma_h C)^2 - \sigma_k\sigma_h(\sigma_a^2)(C)^2 + 2\sigma_a^2C(\sigma_k\sigma_h C) - 2\sigma_a^2C(\sigma_a^2C))^{-1}[2C^2\sigma_h - \sigma_h(\sigma_a^2)(C)^2] + [\sigma_h^2\sigma_a^2(C)^2 - 2C(\sigma_k\sigma_h C) + 2C(\sigma_a^2C) - \sigma_a^2C(\sigma_k\sigma_h C) + (\sigma_a^2C)^2] - (\sigma_k^2\sigma_h^2(C)^2 + \sigma_k^2\sigma_a^2(C)^2 + (\sigma_k\sigma_h C)^2 - \sigma_k\sigma_h(\sigma_a^2)(C)^2 + 2\sigma_a^2C(\sigma_k\sigma_h C) - 2\sigma_a^2C(\sigma_a^2C))^{-2}[2\sigma_k\sigma_h^2(C)^2 + 2\sigma_k\sigma_a^2(C)^2 + 2\sigma_k\sigma_h^2(C)^2 - \sigma_h(\sigma_a^2)(C)^2 + 2\sigma_a^2(C)^2\sigma_h]$$

Simplifying this expression gives:

$$\frac{\partial k}{\partial \sigma_k} = (2\sigma_k^2\sigma_h^2(C)^2 + \sigma_k^2\sigma_a^2(C)^2 + \sigma_k\sigma_h(\sigma_a^2)(C)^2 - 2\sigma_a^2\sigma_a^2(C)^2)^{-1}[2(C)^2\sigma_h$$
$$- \sigma_h(\sigma_a^2)(C)^2]$$
$$+ [\sigma_h^2\sigma_a^2(C)^2 - 2\sigma_k\sigma_h(C)^2 + 2\sigma_a^2(C)^2 - \sigma_a^2\sigma_k\sigma_h(C)^2 + \sigma_a^2(C)^2]$$
$$- (2\sigma_k^2\sigma_h^2(C)^2 + \sigma_k^2\sigma_a^2(C)^2 + \sigma_k\sigma_h\sigma_a^2(C)^2 - 2\sigma_a^2\sigma_a^2(C)^2)^{-2}[4\sigma_k\sigma_h^2(C)^2$$
$$+ 2\sigma_k\sigma_a^2(C)^2 - \sigma_h(\sigma_a^2)(C)^2 + 2\sigma_a^2(C)^2\sigma_h]$$

Now, to determine the sign of $\frac{\partial k}{\partial \sigma_k}$, we apply our assumptions regarding the relative magnitudes of the respective variances. For simplicity we set $\sigma_k^2 > \sigma_a^2 = \sigma_h^2$ .With these assumptions we have that:

$\frac{\partial k}{\partial \sigma_k} =< 0$ as per the first expression in equation (13) of the main text.

Now, in order to evaluate the direction of responsiveness of optimal non-farm capital to an increase in own farm risk $\frac{\partial h}{\partial \sigma_k}$ we construct the following comparative static relationship by expanding our expression for h whereby:

$$h = -\frac{1}{D}((-\sigma_k\sigma_h\rho_{kh}\alpha r\bar{W} + \sigma_h\sigma_a\rho_{ha}\alpha r\bar{W} + \sigma_k\sigma_a\rho_{ka}\alpha r\bar{W} - 2\sigma_a^2\alpha r\bar{W})(\sigma_k\sigma_a\rho_{ka}\alpha r\bar{W} -$$
$$\sigma_a^2\alpha r\bar{W}) + (\sigma_k\sigma_a\rho_{ka}2\alpha r\bar{W} - \sigma_k^2\alpha r\bar{W} - \sigma_a^2\alpha r\bar{W})(2\alpha r\bar{W} + \sigma_a^2\alpha r\bar{W} + \sigma_h\sigma_a\rho_{ha}\alpha r\bar{W}))$$
(A23)

Again to determine the sign of $\frac{\partial h}{\partial \sigma_k}$, in the most tractable manner, we apply our rural Vietnamese contextual assumptions concerning the main risk parameters as follows as outlined in (A4) above:

Evaluating the expression for h:

$$h = -\frac{1}{D}((\sigma_k\sigma_h\alpha r\bar{W} - 2\sigma_a^2\alpha r\bar{W})(-\sigma_a^2\alpha r\bar{W}) + (-\sigma_k^2\alpha r\bar{W} - \sigma_a^2\alpha r\bar{W})(2\alpha r\bar{W} + \sigma_a^2\alpha r\bar{W}))$$

Multiplying out gives:

$$h = -\frac{1}{D}(-\sigma_a^2 \alpha r\bar{W}(\sigma_k \sigma_h \alpha r\bar{W}) + \sigma_a^2 \alpha r\bar{W}(2\sigma_a^2 \alpha r\bar{W}) + 2\alpha r\bar{W}(-\sigma_k^2 \alpha r\bar{W}) + 2\alpha r\bar{W}(-\sigma_a^2 \alpha r\bar{W}) + \sigma_a^2 \alpha r\bar{W}(-\sigma_k^2 \alpha r\bar{W}) + \sigma_a^2 \alpha r\bar{W}(-\sigma_a^2 \alpha r\bar{W}))$$

Removing brackets gives:

$$h = -\frac{1}{D}(-\sigma_a^2 \sigma_k \sigma_h (\alpha r\bar{W})^2 + 2\sigma_a^2 \sigma_a^2 (\alpha r\bar{W})^2 - 2\sigma_k^2 (\alpha r\bar{W})^2 - 2\sigma_a^2 (\alpha r\bar{W})^2 - \sigma_a^2 \sigma_k^2 (\alpha r\bar{W})^2 - \sigma_a^2 \sigma_a^2 (\alpha r\bar{W})^2)$$

And simplifying gives:

$$h = -\frac{1}{D}(-\sigma_a^2 \sigma_k \sigma_h (\alpha r\bar{W})^2 + \sigma_a^2 \sigma_a^2 (\alpha r\bar{W})^2 - 2\sigma_k^2 (\alpha r\bar{W})^2 - 2\sigma_a^2 (\alpha r\bar{W})^2 - \sigma_a^2 \sigma_k^2 (\alpha r\bar{W})^2)$$

Now, we know the expression for the determinant D is:

$$D = \sigma_k^2 \sigma_h^2 (\alpha r\bar{W})^2 + \sigma_k^2 \sigma_a^2 (\alpha r\bar{W})^2 + (\sigma_k \sigma_h \alpha r\bar{W})^2 - \sigma_k \sigma_h \alpha r\bar{W}(\sigma_a^2 \alpha r\bar{W}) + 2\sigma_a^2 \alpha r\bar{W}(\sigma_k \sigma_h \alpha r\bar{W}) - 2\sigma_a^2 \alpha r\bar{W}(\sigma_a^2 \alpha r\bar{W})$$

Applying the determinant gives:

$$h = -(\sigma_k^2 \sigma_h^2 (\alpha r\bar{W})^2 + \sigma_k^2 \sigma_a^2 (\alpha r\bar{W})^2 + (\sigma_k \sigma_h \alpha r\bar{W})^2 - \sigma_k \sigma_h \alpha r\bar{W}(\sigma_a^2 \alpha r\bar{W}) + 2\sigma_a^2 \alpha r\bar{W}(\sigma_k \sigma_h \alpha r\bar{W}) - 2\sigma_a^2 \alpha r\bar{W}(\sigma_a^2 \alpha r\bar{W}))^{-1}[-\sigma_a^2 \sigma_k \sigma_h (\alpha r\bar{W})^2 + \sigma_a^2 \sigma_a^2 (\alpha r\bar{W})^2 - 2\sigma_k^2 (\alpha r\bar{W})^2 - 2\sigma_a^2 (\alpha r\bar{W})^2 - \sigma_a^2 \sigma_k^2 (\alpha r\bar{W})^2]$$

Letting $\alpha r\bar{W} = C$, a positive constant gives:

$$h = -(\sigma_k^2 \sigma_h^2 (C)^2 + \sigma_k^2 \sigma_a^2 (C)^2 + (\sigma_k \sigma_h C)^2 - \sigma_k \sigma_h \sigma_a^2 (C)^2 + 2\sigma_a^2 \sigma_k \sigma_h (C)^2 - 2\sigma_a^2 \sigma_a^2 (C)^2)^{-1}[-\sigma_a^2 \sigma_k \sigma_h (C)^2 + \sigma_a^2 \sigma_a^2 (C)^2 - 2\sigma_k^2 (C)^2 - 2\sigma_a^2 (C)^2 - \sigma_a^2 \sigma_k^2 (C)^2]$$

Determining $\frac{\partial h}{\partial \sigma_k}$ gives by the product rule gives:

$$\frac{\partial h}{\partial \sigma_k} = -\{(\sigma_k^2\sigma_h^2(C)^2 + \sigma_k^2\sigma_a^2(C)^2 + (\sigma_k\sigma_h C)^2 - \sigma_k\sigma_h\sigma_a^2(C)^2 + 2\sigma_a^2\sigma_k\sigma_h(C)^2$$
$$- 2\sigma_a^2\sigma_a^2(C)^2)^{-1}[-\sigma_a^2\sigma_h(C)^2 - 4\sigma_k(C)^2 - 2\sigma_a^2\sigma_k(C)^2]$$
$$+ [-\sigma_a^2\sigma_k\sigma_h(C)^2 + \sigma_a^2\sigma_a^2(C)^2 - 2\sigma_k^2(C)^2 - 2\sigma_a^2(C)^2$$
$$- \sigma_a^2\sigma_k^2(C)^2].-(2\sigma_k\sigma_h^2(C)^2 - 4\sigma_k(C)^2 - 2\sigma_a^2\sigma_k(C)^2)^{-2}\}$$

Now, to determine the sign of $\frac{\partial h}{\partial \sigma_k}$, we again apply our assumptions regarding the relative magnitudes of the respective variances. For simplicity we have set $\sigma_k^2 > \sigma_a^2 = \sigma_h^2$ and with these assumptions we have that:

$\frac{\partial h}{\partial \sigma_k} > 0$ as per the second expression in equation (13) of the main text.

Finally, as $a = 1 - k - h$, we conclude under our assumptions that:

$\frac{\partial a}{\partial \sigma_k} > 0$ as per the the third expression in equation (13) of the main text.

Appendix 3.2: Tables

Appendix Table 3.2.1: Fixed Effects Estimates: Effects of Income Shocks on Household Own-Farm profitability

	Dependent Variable			
	Household Own-Farm profitability (level)			
Independent Variables	(1) Full Sample	(2) Full Sample	(3) Lowest Wealth Group	(4) Lowest Wealth Group
Natural Shocks	-90.454**	-37.587	-40.714	-161.882
	(43.977)	(24.763)	(64.999)	(100.671)
Economic Shocks	180.776***	32.636	104.930	340.232**
	(67.173)	(31.378)	(69.939)	(158.747)
Idio Shocks – Insurable	7.748	-8.134	-29.087	72.425
	(33.257)	(22.458)	(42.870)	(89.819)
Idio Shocks – Not insurable	3.589	-29.944	-8.119	78.725
	(30.556)	(32.375)	(15.657)	(85.279)
Not Recovered Prior Shocks	-53.497**	-29.557	-35.958*	-73.822
	(26.096)	(20.989)	(20.497)	(82.024)
Education	Yes	Yes	Yes	Yes
Household Controls	Yes	Yes	Yes	Yes
Productivity Controls	Yes	Yes	Yes	Yes
Time Dummies	Yes	Yes	Yes	Yes
Constant	-65.424	-55.285	-98.450	37.020
	(70.099)	(53.364)	(117.463)	(200.055)
Observations	5872	1941	1961	1970
R-squared	0.0413	0.0813	0.0544	0.0528
Number of HHid	2039	680	680	679

Robust standard errors are clustered at the household level and are given in parenthesis.
*** indicates significance at the 1% level, ** indicates significance at the 5% level, * indicates significance at the 10% level.

Appendix Table 3.2.2: Fixed Effects Estimates: Effects of Income Shocks on Household Non-Farm(SME) profitability

	Dependent Variable			
	Household Non-Farm (SME) profitability (level)			
Independent Variables	(1) Full Sample	(2) Full Sample	(3) Lowest Wealth Group	(4) Lowest Wealth Group
Natural Shocks	1.853	1.183	0.832	3.170
	(1.246)	(0.995)	(0.981)	(3.439)
Economic Shocks	0.273	-0.036	2.544	-3.672
	(2.943)	(1.803)	(2.198)	(6.477)
Idio Shocks – Insurable	-3.271	-1.334	-2.063**	-7.360
	(2.157)	(1.003)	(0.859)	(7.179)
Idio Shocks – Not insurable	10.040	-2.246	0.776	30.723
	(13.796)	(1.491)	(1.845)	(40.413)
Not Recovered Prior Shocks	0.505	-1.911**	0.239	7.873
	(2.572)	(0.839)	(1.133)	(9.658)
Education	Yes	Yes	Yes	Yes
Household Controls	Yes	Yes	Yes	Yes
Productivity Controls	Yes	Yes	Yes	Yes
Time Dummies	Yes	Yes	Yes	Yes
Constant	-25.884*	-5.467	-3.156	-56.780
	(14.165)	(4.618)	(5.129)	(35.394)
Observations	5872	1941	1961	1970
R-squared	0.0251	0.0199	0.0973	0.0434
Number of HHid	2039	680	680	679

Robust standard errors are clustered at the household level and are given in parenthesis.
*** indicates significance at the 1% level, ** indicates significance at the 5% level, * indicates significance at the 10% level.

Appendix Table 3.2.3: Fixed Effects Estimates: Effects of Covariate Risk Measures on the Change in Aggregate Own-Farm Investment Shares – Middle and Highest Wealth Groups

Independent Variables	***Dependent Variable Change in Aggregate Own-Farm Investment Shares***	
	(3) Middle Wealth Group	(4) Highest Wealth Group
Natural Risk	-0.005	0.029
	(0.040)	(0.039)
Economic Risk	0.031	-0.075
	(0.091)	(0.102)
Idio Risk – Insurable	0.078*	0.012
	(0.047)	(0.058)
Idio Risk – Not insured	-0.060	-0.055
	(0.092)	(0.110)
Not Recovered (Prior)	0.044	-0.050
	(0.044)	(0.053)
Natural Shocks	0.031	0.065*
	(0.041)	(0.039)
Economic Shocks	0.097	-0.013
	(0.088)	(0.077)
Idio Shocks – Insurable	-0.077	0.086
	(0.057)	(0.059)
Idio Shocks – Not insurable	0.075	-0.039
	(0.084)	(0.090)
Not Recovered (Current)	0.072*	-0.061
	(0.043)	(0.045)
Natural Share Loss (Prior)	0.001***	-0.000**
	(0.000)	(0.000)
Other Share Loss (Prior)	-0.048	0.011
	(0.034)	(0.031)
Natural Share Loss (Current)	0.015	0.145***
	(0.037)	(0.035)
Other Share Loss (Current)	-0.006	0.074
	(0.025)	(0.192)
Credit Indicator	0.037	0.105***
	(0.034)	(0.034)
Formal Insurance Indicator	0.005	0.078**
	(0.036)	(0.036)
External Transfer Indicator	0.018	0.007
	(0.031)	(0.032)
Wage Income (Log)	-0.000	-0.011***
	(0.004)	(0.004)
Education	Yes	Yes
Household Size	0.018	-0.003
	(0.022)	(0.023)
Age Controls	Yes	Yes
Time Dummies	Yes	Yes
Constant	0.008	0.124
	(0.390)	(0.398)
Observations	1353	1353
R-squared	681	681
Number of HHid	0.067	0.148

Robust standard errors are clustered at the household level and are given in parenthesis. *** indicates significance at the 1% level, ** indicates significance at the 5% level, * indicates significance at the 10% level.

Appendix Table 3.2.4 Normalized quadratic profit function estimations

Independent Variables Investment Shares	***Dependent Variables Profit (levels)***				
	Total Profit	Farm Profit	Crop Profit	Livestock Aqua Profit	SME Profit
Liquid Assets	-6.902	-7.693	-7.205	-0.488	-4.628
	(6.002)	(5.969)	(5.734)	(0.390)	(3.541)
NonFarm Investment	-21.161	-20.610	-19.308	-1.302	-5.742
	(16.481)	(16.343)	(15.380)	(1.130)	(4.363)
Liquid Assets Sq	0.189	1.046	1.075	-0.029	2.590
	(4.681)	(4.635)	(4.432)	(0.326)	(2.376)
NonFarm Investment Sq	22.273	19.480	18.279	1.201	3.639
	(13.920)	(13.709)	(12.889)	(1.033)	(3.126)
Liquid*NonFarm Inv	26.273	28.179	26.109	2.070	7.085
	(23.610)	(23.524)	(22.202)	(1.559)	(5.602)
Household Controls	Yes	Yes	Yes	Yes	Yes
Risk Controls	Yes	Yes	Yes	Yes	Yes
Household Fixed Effects	Yes	Yes	Yes	Yes	Yes
Time Dummies	Yes	Yes	Yes	Yes	Yes
Constant	5.343	5.243	4.598	0.645	2.138
	(4.026)	(1.023)	(3.753)	(0.072)	(1.534)
Observations	6,051	6,051	6,051	6,051	6,051
Number of HHid	2,042	2,042	2,042	2,042	2,042

Robust standard errors are clustered at the household level and are given in parenthesis.
*** indicates significance at the 1% level, ** indicates significance at the 5% level, * indicates significance at the 10% level.

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