RISK, UNCERTAINTY, AND INSURANCE IN THAI AGRICULTURAL HOUSEHOLDS

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A Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy (Economics)
School of Development Economics
National Institute of Development Administration
2013
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ABSTRACT

Title of Dissertation          Risks, Uncertainty, and Insurance
                                in Thai Agricultural Households
Author                        Aeggarchat Sirisankanan
Degree                        Doctor of Philosophy (Economics)
Year                          2013

For the first time, this paper uses three-wave Thai household panel data for the entire country over the period 2005 to 2007 to investigate the impact of income shocks and income uncertainty on Thai agricultural households based on the permanent income hypothesis (PIH) and precautionary saving hypothesis. It then tests their consumption smoothing mechanisms both over time and across households. The general objective of the study is to test the PIH and precautionary saving hypothesis; specifically to test the impact of income shocks and income uncertainty on agricultural household consumption and then to examine how Thai agricultural households respond to these shocks. The empirical results reveal that the consumption behavior of Thai agricultural households is less consistent with the PIH. On the other hand, Thai agricultural households clearly exhibit precautionary saving motives behavior both in the entire country and in most regions. No impact is found of idiosyncratic shock, proxied by illness of household head, on the households in any region. On the contrary, with idiosyncratic shock, the regression results show an overwhelmingly significant relationship between aggregate shocks, proxied by village-year (tambon) dummy variables with household consumption in every region.

Consequently, with the first results then, the consumption smoothing mechanisms of Thai agricultural households are examined through two main
mechanisms: that is, savings, and borrowings, since they are expected to be a primary mechanism that most households should initially implement. Regressing through the three-wave Thai household panel data, we find that, overall, Thai agricultural households heavily depend on their saving mechanism in smoothing their consumption in the face of income shocks due to rainfall variation, while there is little evidence for using borrowings, either in the entire country or each region. The results also show that savings have a significant relationship with variance of income in every region, whereas households response no to future income uncertainty by borrowings in any region. It is also found that no households in any region use savings or borrowings to smooth their consumption due to the idiosyncratic shock proxied by illness of household head. On the contrary, with the idiosyncratic shock, the regression results still show still a significant relationship between aggregate shocks proxied by village (tambon)-year dummy variables with savings and borrowings in every region, as found in the consumption equation.

In addition to the test of consumption smoothing over time through saving and borrowing mechanisms, consumption smoothing across households is also examined through risk sharing models. Three models are tested regarding this objective; that is, a test of full insurance, a test of partial insurance, and a test of risk sharing through risk sharing instruments. The null hypothesis of full insurance against income risk is rejected for the whole country, together with the group of Central, Eastern, and Western regions. Household consumption appears to be better insured in the group of Central, Eastern, and Western regions than for the entire country. Consequently, with the test of full insurance, further study support the existence of evidence of partial insurance and community risk sharing for the entire country, except for the group of Central, Eastern, and Western regions. Additionally, in order to examine how income risks are actually shared, it is also found that these income shocks are insured by transfer receipts from household nonmembers for the entire country, as well as for the Southern and Northeastern regions.
ACKNOWLEDGMENTS

This dissertation was completed with the help of many people. Several persons were involved in its completion in either direct or indirect ways. First of all, I would like to thank my major advisor, Associate Professor Dr. Pungpond Rukumnuaykit, for many reasons. I first thank her because she opened up to me another world of empirical research in the development economics field that is development microeconomics. This makes me to achieve completely on my goal for the study in Ph.D. economics. I second thank her because she adopted me as her advisee. I last thank her as a major advisor. Her valuable advice helped me to go through this hard work.

I also would like to thank my co-advisor, Professor Dr. Direk Patmasiriwat, and Assistant Professor Dr. Santi Chaisirisawatsuk, for their valuable suggestions and critical comments. Their suggestions always helped me to get through many complicate issues. I also appreciate Dr. Somchai Jitsuchon for his kindness in being a committee chairperson. His generous and valuable suggestions helped me highly in completing the final step of the Ph.D. program. Apart from those that assisted me directly in the completion of this dissertation, I also appreciate all of the faculty members in the Scholl of Development Economics who played a main role in my achievement. Furthermore, many of them helped me in building up a strong foundation in economic theory and the tools I needed with many tough courses during my course work period.

Thanks also go to the faculty of Accountancy and Management at Mahasarakham University where mainly contributes to my Ph.D. completeness. They give me both opportunity and funding during my study, and thus without them, my achievement would have been very difficult. I also thank Dr. Dilaka Lathapipat, who gave me many valuable suggestions about using the complicated techniques of the STATA. I am indebted to Ms. Somkid Tumvong, an officer at the National Statistical Office (NSO), who also advised me initially on the details of the Thai household
panel data set. I also thank my classmates. Without them, the course work period would have been a troublesome time for me.

Finally, I greatly appreciate my family members, who were actually behind my achievement. They have always supported me both financially and in spirit throughout my life. I am deeply grateful to my departed father, who instilled in me the love of learning and a deep interest in political, economic, and social aspects of the academic world. I am also deeply grateful to my mother who has always given me every-thing whenever I asked. My gratitude also goes to my sister and my brother, who have always provided me with both financial and spiritual support.

Aeggarchat Sirisankanan
October 2013
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CHAPTER 1

INTRODUCTION

1.1 Statement of the Problem and Its Significance

The importance of the agricultural sector in the economic development of most countries is well known and can hardly be overemphasized. Farmers have played a crucial role in the great wealth of today’s industrial countries and the remarkable improvements in the well-being of the people of the developing countries over the past half century (Johnson, 1997: 1). Similar to most developing countries, Thai agriculture used to be the engine of industrial growth by supplying cheap food and labor, generating tax revenue and foreign exchange, and providing a market for industrial output during the 1960s and 1970s (Nipon Poapongsakorn, Ruhs, and Sumana Tangjituisuth, 1996: 3; Medhi Krongkaew, 1985: 325; Ammar Siamwalla, 1996: 3).

Nowadays, although there is still no clear alternative for the future of the Thai agricultural sector, it is generally accepted that there are still a large number of households residing in the agricultural sector, especially in rural areas. In 2008, there was still 37.6 percent of the population and 44.2 percent of the labor force in the agricultural sector, albeit the share of the agricultural sector in the total GDP declined to 11.6 percent from 45.2 percent and 25.9 percent in 1950 and 1970 respectively. Agriculture, hunting, and forestry represent the largest proportion of the Thai agricultural sector, with a share of about 90 percent, while fishing at 10 percent makes up the remainder. In addition, about 50.6 percent of Thai agricultural land is paddy, followed by farm crops, rubber, and perennial crops, fruit and forests, with a share of about 19.7 percent, 12.1 percent and 10.5 percent respectively. These data reflect clearly that even if the Thai agricultural sector has currently less part in Thailand’s economic growth, a large number of Thai households still depend either directly or
indirectly on the agricultural sector, and thus Thai household welfare is engaged inevitably in the welfare of these households.

Like most developing countries, Thai agricultural households, especially in rural areas, not only cope with low income but also with extremely variable income. Agricultural income is inherently uncertain as a result of two main types of risk: idiosyncratic and covariate risks. Idiosyncratic risks are those that are specific to particular farmers, such as illness and crop pests, while covariate risks affect and are common to all farm households, such as weather and price shocks. Both types of risks are beyond the control of agricultural households and then cause them serious hardship. However, according to Milton Friedman’s permanent income hypothesis (PIH), which assumes the strictly assumption, it is possible that if there are complete markets for credit, or if there are some other mechanisms, then transitory income shock (both idiosyncratic and covariate shocks) should be smoothed away by borrowings and savings and they should not affect consumption patterns. However, because credit and insurance markets in most developing countries often do not exist or function only imperfectly, the agricultural households in those countries need ways to protect themselves against the risk of a bad year. Finding ways to smooth out their consumption between good years and bad can mean the difference between life and death (Case, 1995: 81).

The study of the impact of shocks on consumption or specifically the testing of the PIH has been proposed in various empirical specifications both in developed and developing countries since Milton Friedman’s initial formulation of the theory in 1957. The overall conclusion of these studies nonetheless rejects the PIH, for example, Hall, 1978: 971-987; Bhalla, 1980: 722-744; Zeldes, 1989(a): 275-298; Alderman, 1996: 343-365; Stillman, 2001: 1-26; Kazianga and Udry, 2006: 413-446. Researchers frequently appeal to an increase in the precautionary saving motive generated by increases in income uncertainty, for example, Skinner, 1988: 237-255;

---

1 Covariate risks can be also called systemic or aggregate risks.
2 Actually, Friedman (1963) predicts the marginal propensity to consumer out of transitory shock about 0.33 even if Friedman (1957) have ever state that it should be zero (Carroll, 2000: 6).
3 The rejection and the acceptance of the PIH depend on whether a conclusion is base on the weaker version or the strict version of the PIH. For the strict version, temporary shock to income (transitory income) should not affect the current level of consumption. On the other hand, a weaker version, transitory income, can affect some level of consumption. However, the strict version of the PIH is rarely accepted (Alderman and Paxson, 1992: 10).

This study focuses specifically on the role of the precautionary saving motive in complement with the PIH since precautionary savings is one of the most importance ideas which try to bridge the gap between theoretical and actual behavior by relaxing the simplifying assumptions of the standard model of the PIH. The certainty equivalence assumption, which generates the standard model of the PIH, yields convenient characterization of behavior as a result of the assumption of quadratic utility, however, is quite stringent and, in most contexts, highly implausible (Blanchard and Mankiw, 1988: 173). The precautionary saving model presents two more attractive utility functional forms: constant absolute relative risk aversion (CARA) and constant relative risk aversion (CRRA), which produces the positive third derivative of the utility function and convexity in marginal utility. Consequently, consumption depends not only spread of resources over the life cycle as the standard model of the PIH, but also on uncertain events, such as income shocks (Lusardi, 1998: 449).

The precautionary saving motive is one of the main ideas that, can explain why the PIH is rejected, and thus it may cause the marginal propensity to consume out of permanent income at less than one in most empirical studies. Having the precautionary saving motive, households need to save for a rainy day; that is, they need to save protect against consumption shortfall in the face of future income uncertainty. With this motive, therefore, when household permanent income rises, household consumption may not increase one to one, as explained by the PIH, since households need to reduce some of their consumption to increase their savings due to concerns about in income uncertainty in the future. Regarding this idea, therefore, it would be more appropriate to study the consumption behavior of households under a more reasonable model.

In the context of Thai agricultural households, a strict version of the PIH has hardly been found, as with most developing countries, although there are a few studies that focus on Thailand, for example, Paxson, 1992: 15-33; Paxson, 1993: 39-72; Townsend, 1995: 83-102. Additionally, most of these studies overlook the
importance of the precautionary saving idea in their consumption or saving model, and then this leads to a lack of a reasonable explanation of their results. Thus, in order to complement this gap, this study reexamines the impact of income shocks on Thai agricultural households since Paxson’s study in 1992. This study does not nevertheless only focus on the effect of income shocks due to rainfall variation but also focuses on income uncertainty, which is constructed with using the inventive technique of Kazianga and Udry (2006: 434), to show how the precautionary saving motive influences the consumption of Thai agricultural households. In addition to testing the PIH with the complete model\(^4\), there are several changing remarks in the Thai economy which may be significantly different from in the previous study results, and thus lead to reasonableness in reexamining the test of the PIH of Thai agricultural households. First, over the past two decades, the Thai economy has expanded continuously, and thus the Thai GDP per capita income increased from 21,157 baht to 124,377 baht in 1986 and 2007 respectively. Second, the amount of poverty in Thailand, measured by the headcount ration reduces also from 29.50 to 8.48 in 1986 and 2007 respectively. Third, Thailand’s financial development, proxied by \(M_2/GDP\), increased from 0.36 in 1986 to 2.14 in 2007. Fourth, excluding a large number of a small irrigable project, there has been a greater increase in medium and large irrigable projects. Before 1986, there were 443 medium and large irrigable projects; however, these projects increased to 778 in 2006. Finally, in comparison with the past, it can hardly be rejected that nowadays climate change has become much more of a critical and global challenge for this generation and possibly for future ones, and doubtlessly, this affects Thai households, especially agricultural households\(^5\).

\(^4\) Models which incorporate precautionary saving such as the buffer stock model appear to perform better implying that concave consumption functions best model consumption (Fernandez-Corugedo, 2004: 29)

\(^5\) ”Even with global emission of greenhouse gases drastically reduced in the coming year, the global annual average temperature is expected by 2°C above preindustrial level by 2050. A 2°C warmer world will experience more intense rainfall and more frequent and more intense droughts, floods, heat waves, and other extreme weather events” (Worldbank, 2010: 1).
Similar to the study of Paxson (Paxson, 1992: 15-33), this study still focuses on the PIH test but more weight is placed on the impact of the precautionary motive on household consumption. Furthermore, there are several different specifications in the present study. First, this study chooses the consumption model rather than the saving model to consist with most studies that chooses to model consumption on micro data (Browning and Lusardi, 1996: 1825). Second, this study uses three wave panel data of Thai households, which cover the years 2005 to 2007. Relying on a single cross-section survey as in Paxson’s study requires the analyst to make strong assumptions⁶. Using panel data therefore greatly enhances the scope of risk and vulnerability assessment (Hoddinott and Quisumbing, 2003: 28). Third, to take advantage of the availability of panel data, our model includes also village (tambon)-year dummy variables. The interaction between villages and years not only captures village-specific effects which reflect the differences in economic, social, cultural, weather and other factors that may influence to households in different villages at the different time, but also captures the aggregate shocks, which are common across groups of members and cannot be smoothed out by those within the villages. Fourth, in order to predict transitory income shocks, this study not only uses rainfall data but also interacts with farm characteristics, so that the difference in transitory income across households is purely random. Fifth, this study attempts also to add a specific adverse shocks rather than relying on only income shocks to investigate whether these shocks affect a household’s well-being. However, due to the limited data, only illness of the household head is a proxy of specific adverse shock. Finally, concerning the gap between theoretical and actual behavior, this study combines the PIH with the precautionary saving model by including income uncertainty, which is constructed following the technique of Kazianga and Udry (2006: 434); that is, it is estimated using the time-series of rainfall variation, interacting with household land characteristics weighted by the estimates from the income equation in the consumption model. Consequently, this study examines the impact of both the first moment and the higher moment of income shocks.

Additionally, in order to cover the study in the impact of risks and uncertainty on household consumption, apart from the investigation as to whether income shocks⁶ See the details in Hoddinott and Quisumbing (2003: 29).
and income uncertainty affect Thai agricultural household consumption, this study also examines how households respond to both income shocks and income uncertainty. Alderman and Paxson (1992: 1-2) categorize consumption smoothing mechanisms into two main mechanisms. First are risk managements, which include crop and field diversification, income source diversification, sharecropper tenancy, and migration of family members. Second are risk copings, which can be classified as those that smooth consumption intertemporally, through borrowings, selling assets, savings and remittances, and those smooth consumptions across space (households), through risk sharing. However, with the limitation of the data, this study examines how households respond to both income shocks and income uncertainty only through two main types of risk coping strategies, that is, consumption smoothing over time through savings and borrowings and consumption smoothing across households through risk sharing.

The remainder of the study is planned as follows: Sections two outlines the theoretical framework of modeling consumption smoothing over time, together with a review of the literature on PIH tests. Section three explains the methodology, which includes the empirical specifications, econometric strategy, and data description. Section four represents the results of the empirical analysis concerning the impact of income shocks and income uncertainty on household consumption. Consequently, after the previous section, section five presents an extension of the study concerning the impact of income shocks and income uncertainty on household consumption by examining consumption smoothing mechanisms through saving and borrowing mechanisms. Section six presents another extension of the study by examining another consumption smoothing mechanisms; that is, risk sharing. The final section concludes and proposes policy implications.

1.2 Objectives of the Study

The general objective of the study is to test the PIH and precautionary saving hypothesis, specifically to test the impact of income shocks and income uncertainty on agricultural household consumption. It then examines how Thai agricultural
households respond to these shocks. Specifically, this study presents four main objectives as follows:

1.2.1 To examine the impact of transitory income shock on agricultural household consumption
1.2.2 To examine the impact of income uncertainty on agricultural household consumption
1.2.3 To examine how Thai agricultural households smooth their consumption in the face of transitory income shock and income uncertainty
1.2.4 To investigate the evidences on risk sharing in Thai agricultural households
CHAPTER 2

THEORECTICAL FRAMEWORK AND LITERATURE REVIEW

Consumption is always one of many indicators which represent a household’s well-being, or even one of the dimensions of a household’s welfare. Understanding how a household’s allocation of its incomes between consumption and savings under some constraints can lead to effective policy implications, both at micro and macro levels. Consumption theory, which explains households’ consumption behavior, has been developed in an evolutionary way since the absolute income hypothesis of John Maynard Keynes, which is known as the traditional consumption theory. Nowadays, with stronger foundation and empirical evidence, the modern consumption theories, which combine Friedman’s permanent income hypothesis (PIH) with Modigliani and Brumberg’s life-cycle hypothesis (LCH), and are known as the life cycle-permanent income hypothesis (LC/PIH), have become the mainstream of consumption theory.

However, due to the simplifying assumptions of the theory, this makes for a discrepancy between theory and some crucial real-world characteristics. Consequently, several studies reject the LC/PIH and try to bridge this gap by relaxing the simplifying assumptions of the original theory. This contributes to the extended version of the LC/PIH, and this study uses this term for the meaning of LC/PIH, which relaxes some simplifying assumptions.

The objective of this chapter is to explain the theoretical model that underlines the empirical work about the impact of income shocks and income uncertainty on household consumption, and surveys the literature, which is involved directly with such studies. To explain consecutively, this chapter nevertheless will divide the LC/PIH into two versions: the standard (original) version and the extend version.

---

7 The earliest work about consumption and saving actually originated in Irving Fisher’s theory of interest in 1907.
8 The main difference between LCH and PIH in their original formulation lies in the time horizon considered. LCH is, almost by definition, a finite horizon model, while with PIH the horizon is infinite (Attanasio, 1999: 761).
Under this framework, each version will be explained sequentially together with reviewing the related literatures on each version.

2.1 The Standard Version of the Life Cycle-Permanent Income Hypothesis

The standard version of the life cycle-permanent income hypothesis is widely accepted as the theory of the consumer regarding the problem of dividing consumption between the present and the future. According to this hypothesis, household consumption responds on a one-to-one basis to the annuity value of the sum of expected human and non-human wealth, which is known as permanent income⁹, but is insensitive to transitory income.¹⁰

The standard version of the LC/PIH is a special case of the general theory of intertemporal choices, which formulates the trade-offs between present and future consumption.

Under this version, the household’s utility function takes the form:

\[
U = E \left[ \sum_{j=0}^{\infty} \left( \frac{1}{1+\delta} \right)^j U \left( C_{it} + j \right) \right],
\]

where \( E[\cdot] \) is the household’s conditional expectation of some variables at time \( t \), which implies that household have rational expectations, \( U(\cdot) \) is the concave instantaneous utility function which is assumed to be additively separable from the identical sub-utility functions for each period¹¹. In addition, we assume that the utility function is increasing in consumption and strictly concave: \( U'(c) > 0, U''(c) < 0 \), and assume that:

---

⁹ The original permanent income hypothesis developed by Friedman assumes actually adaptive expectation, and thus permanent income is approximated by a geometrically declining weighted average current and past actual income (Fernandez-Corugedo, 2004: 4).

¹⁰ This version is also known as the rational expectation permanent income hypothesis.

¹¹ This utility is also called an intertemporally additive or a strongly intertemporally separable, and it is the most widely used assumptions of preferences (Deaton, 1992: 4).
\[
\lim_{c \to 0} U'(C) = \infty ,
\]

which implies that households always desire at least a little consumption in every
period (always positive consumption), \( C_{it+j} \) is the consumption of household \( i \) in
period \( t+j \), and \( \delta \) is the rate of subjective time preference or the discount rate\(^{12}\).

Assets evolve according to the interest rate and the proportion of income
which is consumed or saved:

\[
A_{it+j} = (1+r_{t+j}) (A_{it} + Y_{it} - C_{it}) .
\]

Let \( T \to \infty \), we get the intertemporal budget constraint of the form:

\[
\sum_{j=0}^{\infty} \frac{1}{(1+r_{t+j})} C_{it+j} = A_t + \sum_{j=0}^{\infty} \frac{1}{(1+r_{t+j})} Y_{it+j}
- \lim_{T \to \infty} \frac{1}{(1+r_{t+j+1})} A_{t+j+1} .
\]

Imposing the no-Ponzi-Game condition (transversality condition): otherwise,
households can borrow and consume infinitely (Romer, 2006: 52):

\[
\lim_{T \to \infty} \frac{1}{(1+r_{t+j+1})} A_{t+j+1} = 0 .
\]

We then rewrite equation (3) with uncertainty case:

\(^{12}\) Similar to an interest rate, the discount rate discount future utility as that the lifetime utility function
represents the present value of utility. Thus the greater of the discount rate implies that the less of the
household value future consumption relative to current consumption.
\[
E_t \sum_{j=0}^{\infty} \frac{1}{(1+r_t+j)} C_{t+j} = A_t + E_t \sum_{j=0}^{\infty} \frac{1}{(1+r_t+j)} Y_{t+j},
\]

(5)

where \( A_t \) is initial asset wealth, \( Y_t \) is human wealth (labor income), and \( r \) is the real interest rate.

Without a liquidity constraint, the problem for the household is to choose a consumption sequence \( \{C_t\}_{t=1}^{\infty} \) that maximizes (1) subject to (2), and by using the dynamic optimization technique, this study applies the Bellman equation\(^{13}\).

The Bellman equation is a recursive representation of a maximization decision. Specifically, it represents a maximization decision as a function of a smaller maximization decision. The Bellman equation collapses the infinite horizon problem into a sequence of two-period problems. This thus involves two steps. First, writes (1) in the form of the value function, \( V(A_t) \)\(^{14}\), and, second writes the value function in the recursive form as follows:\(^{15}\)

\[
V(A_t, Y_t) = \max E_t \left[ \sum_{j=0}^{\infty} \beta^j U(C_t) \right] \quad \beta = \frac{1}{(1+r_t+j)},
\]

(6)

\[
= \max \left[ U(C_t) + \beta E_t \left\{ \sum_{j=0}^{\infty} \beta^j U(C_{t+j+1}) \right\} \right],
\]

(7)

\[
= \max \left[ U(C_t) + \beta E_t V(A_{t+1}, Y_{t+1}) \right]
\]

(8)

and subject to

\(^{13}\) There are two main ways of solving dynamic optimization problem: (i) either by sequential methods, i.e. using the Lagrangian methods; (ii) or by recursive methods (dynamic programming), i.e. Bellman equation and Hamiltonian.

\(^{14}\) The value function is completely analogous to out the indirect utility function in the static problem.

\(^{15}\) For convenience, subscript \( i \) (denoted for households) is dropped in this section.
\[ A_{t+1} = (1 + r_{t+1})(A_t + Y_t - C_t). \]  

(9)

Equation (8) is known as the Bellman equation or a functional equation, which implies that the value of current resources is equal to the maximized value of current consumption plus the discounted expected value of resources next period\(^{16}\).

It is nonetheless more convenient to solve this problem by turning it into an unconstrained one:

\[
\begin{align*}
V(A_{t+1}, Y_{t+1}) &= \max_{c_t} \left\{ U(C_t) + \beta EV[(1 + r_{t+1}) \right. \\
& \left. (A_t + Y_t - C_t) + Y_{t+1}] \right\},
\end{align*}
\]

(10)

assuming \( V(\cdot) \) is differentiable, the first order condition (F.O.C) will be

\[
U'(C_t) = (1 + r_{t+1}) \beta E_t V'(A_{t+1}, Y_{t+1}),
\]

(11)

applying then the envelope theorem\(^{17}\), equation (11) is rewritten as

\[
U'(C_t) = (1 + r_{t+1}) \beta E_t U'(C_{t+1}).
\]

(12)

Equation (12) is known as the consumption Euler equation, which represents the dynamics of the relationship between current consumption and consumption in the next period. It indicates that a household’s consumption decision is made so that the

\(^{16}\) In the recursive interpretation, this indicates that choosing a value for the choice variable today (say \( C_t \)), given an initial value for asset wealth \( A_0 \), has two effects consecutively. First it directly affects today’s objective function (through \( U(C_t) \)). Second, it affects the optimal decisions for next periods’s choice variable (through \( EV(A_{t+1}) \)).

\(^{17}\) The envelope theorem tells us that the derivative of a maximum is equal to the derivative of the objective function, evaluated at the maximum. This also is known as Benveniste and Scheinkman’s formula (Sargent, 1987: 23).
marginal utility of current consumption is set equal to the discounted expected marginal utility of the next period’s consumption (Bardhan and Udry, 1999: 101). In the simpler form, if the real interest rate is constant and equal to the rate of the time-preference, equation (12) becomes:

\[ U'(C_t) = E_t U'(C_{t+1}). \]  

(13)

Given a specification of preferences, the intertemporal budget constraint, and the Euler equation (13) we can in principle solve for the consumption function by assuming the utility function is quadratic i.e.,

\[ U(C_t) = C_t - \frac{a}{2} C_t^2, \quad a > 0, \]  

(14)

so that

\[ U'(C_t) = 1 + aC_t > 0, \]
\[ U''(C_t) = -a < 0, \]
\[ U'''(C_t) = 0, \]

then equation (13) become:

\[ 1 - aC_t = E_t (1 - aC_{t+1}), \]  

(15)

---

18 In other words, the Euler equation indicates that the marginal cost of savings \( (U'(C_t)) \) is equal to the marginal benefit of savings \( [(1+r_{t+1})bE_t U'(C_{t+1})] \) in the utility measure. We therefore cannot gain utility by making a feasible switch of consumption from one period to the next.

19 Since \( U'''(C_t) = 0 \), its marginal utility is neither concave nor convex and the Jensen relationship is an equality; thus the zero third derivative implies that there is no precautionary saving motive.
\[ 1 - aC_t = 1 - aE_t(C_{t+1}), \quad (16) \]

\[ C_t = E_t(C_{t+1}), \quad (17) \]

or equivalent to\(^{20}\)

\[ C_{t+1} = C_t + \varepsilon_{t+1}, \quad (18) \]

where \( \varepsilon_{t+1} \) is an innovation or martingale difference (Deaton, 1992: 27).

Equation (17) and (18) state Hall’s famous result, where under the standard version of the LC/PIH, consumption follows a random walk and changes in consumption are unpredictable that is only consumption lagged one period should have a nonzero coefficient, while other economic variables that are observed in earlier periods should be unrelated to consumption. In particular, lagged income should have no explanatory power with respect to consumption (Hall, 1978: 972).

To solve the consumption function, note that equation (17) implies

\[ E_t(C_{t+j}) = C_t. \]

Substituting this into (5) yields:

\[ C_t = \left( \frac{r}{1+r} \right) \left[ A_t + E \sum_{j=0}^{\infty} \frac{1}{1+r+j} Y_{t+j} \right]. \quad (19) \]

Equation (19) indicates that the standard version of the LC/PIH, which represents current consumption, is the annuity value of current assets plus the present value of the expected stream of future income. In addition, under this framework, the household’s behavior exhibits a certainty equivalence that implies that the household consumes the amount household would if household future income was certain to equal their means; that is, uncertainty about future income has no impact on

\(^{20}\) Equation (18) shows that consumption follows a martingale as in the language of stochastic process.
consumption (Romer, 2006: 355). In other words, the household’s behavior is the same as when mean income is known with certainty.

Since the change in consumption will be equal to the annuity value of the present value of the change in the expected stream of future income, the key implementation of this is if the income shocks are transitory, and there is little or no change in the household’s expectations concerning its future income stream, then consumption will change little in response to the income shocks. However, in the case of a large change in the household’s expectations concerning its future income stream due to the income shocks, then the income shocks will be seen as permanent and consumption will change dramatically in response to income shocks (Bardhan and Udry, 1999: 103).

Over the past three decades, since the work of Hall (1978: 917-987), the literature about testing on the standard version of the LC/PIH, which states that, in the perfect case, household consumption responds one-to-one basis to permanent income, but is insensitive to transitory income, has been abundant and various extensions and applications. Reviewing this literature all at once, nonetheless, may be redundant and complex. Thus, to be specific regarding these works we will focus only on the literature, which is based on the PIH and tests directly on the effect of income shocks on consumption and savings in this part of the study and leave other extensions of testing the standard version of the LC/PIH to the relevant section of the study.

\[ E_t(U'(C_t)) = E(1 - aC_t) = 1 - aE_t(C_t) = U'(E_t|C_t). \]

Hence equation (12) is equivalent to

\[ U'(C_t) = (1 + r_{t+1})\beta U'(E_t|C_t). \]

Note that quadratic utility is the source of certainty equivalence behavior. When utility is quadratic and marginal utility is linear, the expected marginal utility of consumption is the marginal utility of expected consumption so that the degree of uncertainty will not affect marginal utility:

From the macroeconomic perspective, this theory indicates that consumers will ignore business-cycle related income shocks (as well as short-run, traditional Keynesian government intervention such as tax cut and spending increases). Contrarily, consumption’s decision depends on real wealth, which are the long-term factors such as equity assets, health, expected retirement age, and education level (Gravelle, 2007: 3).

The extension and application in the standard version of the LC/PIH are various, for example, testing risk managements, risk copings which include consumption smoothing with assets, labor selling etc., and risk sharing, including the extension of the model such as precautionary savings and liquidity tests.
There is much literature which tests the effect of income shocks on consumption and savings, but the overall conclusion is a rejection of the strict version of the LC/PIH\(^{24}\). Most initial empirical literatures about the LC/PIH stem from Hall’s (1978: 971-987) random walk hypothesis. They try to prove whether changes in consumption are unpredictable. In addition, most of these investigate this hypothesis with aggregate data even if some literatures tries to investigate it with cross-sectional and panel data. Hall (1978: 971-987) tested his random walk hypothesis by using U.S data. He regressed consumption with various lagged variables, such as lagged consumption, lagged income, and lagged stock prices. Hall found that neither lagged consumption nor lagged income was statistically significant and that the null hypothesis that consumption follows a random walk should not be rejected. However, lagged stock prices were found to have predictive power for consumption and thus it violates the random walk hypothesis\(^{25}\). Bhalla (1979: 295-307) tested the PIH with a three-year panel survey for household in rural India. He extended Freidman’s permanent income model by explicitly allowing for the distinction between pure measurement errors and transitory terms in the observed variables. He also tried to separate households into subsistence households and non-subsistence households to test the PIH. His overall conclusion, however, is the rejection of the PIH; that is, the marginal propensity to consume out of permanent income of both types of households is less than one.

Musgrove (1979: 355-368) estimated the consumption in urban South America by directly estimating permanent income with household characteristics such as age, education, and occupations. His results revealed that the average elasticity of consumption with respect to permanent income was clearly less than one. Bhalla (1980: 722-744) reexamined the saving-income relationship for farm households in rural India by using panel data to construct two measures of permanent income; that is, a modified earnings function and a weighted average of past incomes. His results

\(^{24}\)Some literatures may consist of many tests in at once, however, only the directly relevant tests will be summarized in this part of the study.

\(^{25}\)Albeit most contemporary literature stems from Hall’s (1978: 971-987) random walk hypothesis, there are several studies that have tried to test the PIH before Hall’s work, for example, Bodkin (1959: 602-614), Jones (1960: 584-592), Kreinin (1961: 388-390), and Holmes (1970: 1159-1162).
indicated that the marginal propensity to save out of transitory income was higher than the marginal propensity to save out of permanent income, but less than one. Flavin (1981: 974-1009) reinvestigated Hall’s random walk hypothesis by developing a simple structural econometric model of consumption and assuming that income follows an autoregressive-moving average (ARMA). This allowed her to test the random walk hypothesis by regressing consumption on current income. Her results showed that the sensitivity of consumption to changes in current income was far greater than the PIH prediction, and this result has become known as “the excess sensitivity of consumption.” Hall and Mishkin (1982: 461-481) retested the PIH with an alternative test and data. They tested the PIH by testing the sensitivity of consumption to permanent and transitory income with U.S. panel data (the Panel Study of Income Dynamics: PSID). Their results indicated that even though consumption responds much more strongly to permanent than transitory income, the response to the transitory is vigorous, and thus they rejected the pure PIH. Campbell and Mankiw (1989: 185-216) took a different approach to testing the random walk hypothesis with aggregate postwar U.S. data. They assumed fraction $\lambda$ of the population represented rule of thumb consumers (Keynesian consumers) and fraction $(1-\lambda)$ behaved according to the PIH. Then they regressed the change in consumption at time $t$ on the change in income at time $t$ to estimated $\lambda$, using a set of instruments. Among the various instrument variables, lags of the change in consumption were considered valid instruments, and thus the estimate of $\lambda$ was around 50%, which indicated that there was a substantial departure from the PIH since half of the population are rule of thumb consumers while the remainder are PIH consumers.

26 Even though the structural approach does not provide a statistically more powerful test, in general, than Hall’s reduced form approach, it does have the advantage of providing estimates of the structural parameter of the model, including estimates of the excess sensitivity of consumption to current income (Flavin, 1981: 1007).

Deaton’s Paradox is another empirical anomaly of the test of the PIH. The PIH predicts that consumption is smooth because permanent income is smoother than measured income. However, permanent income is indeed less smooth than current income so that the PIH fails to offer a well-supported account of why consumption is smoother than income (Campbell and Deaton, 1989: 357). Deaton (1986: 1-47) argued that if labor income is difference stationary the PIH should predict that consumption will be relatively volatile, but if labor income is characterized as an integrated process (unit root), consumption turn out to be relatively smooth (Quah, 1990: 449). Gali (1991: 1238-1253) reaffirmed this excess smoothness of consumption by testing the hypothesis with U.S. postwar data. His results suggested that consumption is still smoother than in the PIH prediction\(^\text{28}\). In the 1990 decade, Campbell and Mankiw (1990: 265-279) reexamined the consistency of the standard version of the LC/PIH by using aggregate postwar U.S data. They found that 50 approximately percent of were rule of thumb consumers, who simply consumed at their current income.

By using data from Thailand, Paxson (1992: 15-33) examined how Thai farm households respond to transitory income by using three cross sections of income and expenditure data drawn from the SES. The challenge of Paxson’s study has been the decomposing of income into transitory and permanent income, especially transitory income, where she uses time-series information on regional rainfall in conjunction with cross-sectional data on farm household income to explicitly measure transitory income shock. Her results revealed that the propensities to save out of transitory income due to rainfall shocks are quite high. Shea (1995: 186-200) used another approach in testing the random walk hypothesis. He tried to identify predictable changes in income by isolating households in PSID that could be matched to particular long-term union contracts and tested the hypothesis by using published contract provisions to construct a household-specific measure of predictable wage

growth. He found that expected wage growth was significantly correlated with consumption growth, contrary to the random walk prediction.

Alderman (1996: 343-365) followed Paxson’s (1992: 15-33) approach in decomposing income to test the relationship between savings and permanent income as well as transitory income for households in rural Pakistan. He took advantage of panel data in estimating permanent income, which was defined as the average of income predicted for each of the year specific coefficients using household composition and assets held in any given year. His results showed that even though savings were used to cushion transitory shocks, consumption smoothing mechanisms appeared to break down under repeated shocks. Lusardi (1996: 81-90) used data from two data set for consumption and income data. She found evidence that consumption is excessively sensitive to current income and thus the predictions of the rational expectations-permanent income model were rejected. As with several previous studies, Miles (1997: 1-5) used a two-step estimation to test the PIH with micro data from the UK. He estimated the determinants of household income and measure how human capital and earnings uncertainty affected consumption. He found that the estimated permanent income and earnings uncertainty had powerful effects on household spending. Unlike several studies, Kochar (1999: 50-61) used a panel data set of Indian farm households and found that idiosyncratic crop income shocks had an insignificant effect on consumption even if the coefficient was not zero, as explained by the PIH.

The rejection of the standard version of the LC/PIH is still confirmed repeatedly for the new decade. Stillman (2001: 1-26) used representative panel data on urban households from the Russian Longitudinal Monitoring Survey. His results showed that exogenous economic shocks have large and significant effects on both food and non-durable expenditure and thus the traditional LC/PIH was firmly rejected in term of describing the behavior of Russian households. Pistaferri (2001: 465-476) estimated the saving equation using the 1989-1991 panel section of the Bank of Italy Survey of Household Income and Wealth, and found that savings not only responded to transitory income shocks but also to permanent income shocks. Meng (2003: 465-485) found a similar result by using data from urban China; that is, the marginal propensity to consume out of permanent income was significantly greater than the marginal propensity to consume out transitory income in all cases, even though it was
not equal to unity. Ersado, Alwang and Alderman (2003: 187-215) examined the changes in consumption and saving behavior of households in Zimbabwe before and after weather shocks and economic shocks. Their results revealed that households consumed the majority of their permanent income and saved the majority of their transitory income before the droughts and structural adjustments. However, after the droughts and structural adjustments, households consumed the majority of both permanent and transitory income, but saved the minority of both permanent and transitory income.

Dercon (2004: 309-329) used panel data from rural Ethiopia to examine the determinants of consumption growth. His results showed that rainfall shocks did not just strongly affect food consumption in the current period, but its impact lingered on for many years. Dercon, Hoddinott and Woldehanna (2005: 559-585) examined the impact of different types of shocks on consumption using unique longitudinal household data in rural Ethiopia. They found that drought shocks and illness shocks were the most important shocks that reduced per capita consumption. In addition, they found that some shocks appeared to have long lasting effects. Dejuan and Seater (2006: 27-46) improved and retested Friedman’s income elasticity test, which states that the income elasticity of consumption should be higher for households for which a large fraction of the variation of the income is permanent than for households experiencing more transitory variations in income. Their results supported the PIH. The strongest implications of the PIH were nonetheless rejected. Kazianga and Udry (2006: 413-446) examined the consequences of severe income shocks generated by

29 The current income elasticity of consumption \( \eta_{cy} \) can be written as

\[
\eta_{cy} = \frac{\hat{c}_c/\hat{c}_y}{c/y},
\]

or equivalent to the marginal propensity to consume divided by the average propensity. However, the marginal propensity to consume equals the slope coefficient \( \beta_y \) in a cross-section regression of current consumption on current income. Then the PIH implies that the estimated value of \( \beta_y \) is

\[
\beta_y = \frac{\text{var } y^P}{\text{var } y^P + \text{var } y^T},
\]

where \( \text{var } y^P \) is permanent income variations and \( \text{var } y^T \) is transitory income variations.


droughts for the food consumption of a sample of farming households in rural Burkina Faso. It turned out there was little evidence of consumption smoothing either over time or across households within the villages. The small amount of consumption smoothing that they found was affected largely through the accumulation and decumulation of stocks of grain. Similar to Flavin (1981: 974-1009), DeJuan, Seater and Wirjanto (2006: 613-629) investigated the key stochastic implication of the PIH that an income innovation generates the same size revision in consumption as in permanent income using time-series data from 11 West-German states. Their empirical results did not support this hypothesis, in the sense that the response of consumption to income innovations was found to be much weaker than the PIH’s prediction. Davies (2010: 75-79) performed similar tests as that of Dercon et al. (2005: 559-585) using Malawian panel data. The results indicated that sickness and droughts had a short-run negative impact on per capita consumption levels, but no persistent impact, while flooding had no immediate impact, but a positive longer-run impact.

2.2 The Extended Version of the Life Cycle-Permanent Income Hypothesis

The standard version of the LC/PIH is generally accepted as the primary theoretical framework for modeling the determinants of consumption and saving decisions of households. Yet the simple model of the standard version of the LC/PIH overlooks some crucial real-world characteristics, and seriously deteriorates its theoretical and empirical validity. This can be seen in the previous section, where most studies rejected the standard version of the LC/PIH.

The failure of the standard version of the LC/PIH has therefore motivated a substantial amount of research on extensions to the theory by relaxing the simplifying assumptions of the standard model. There are several ideas that attempt to bridge this gap; however, two main ideas have received particular attention; that is, precautionary savings and liquidity constraints.

30 Other extensions of the standard version of LC/PIH include departure from full optimization, durability of consumption goods, habit formation, and nonexpected utility (Romer, 2006: 371).
2.2.1 Precautionary Savings

The importance of precautionary savings can hardly be overemphasized (Dardanoni, 1991: 153). The theory of precautionary savings emphasizes that consumption depends not only on spread resource over the life cycle, but also on uncertain events, such as income shocks (Lusardi, 1998: 449). The basic idea is that, since future labor income is uncertain and since individuals (or household) cannot fully insure against idiosyncratic income risks, there is therefore a motive to “save for a rainy day” (Pemberton, 1993: 1)\textsuperscript{31}.

The precautionary savings is entirely consistent with the basic theory of intertemporal allocation, but is ruled out by the certainty equivalence assumption, which generates the standard of the LC/PIH. Certainty equivalence yields convenient characterizations of behavior as a result of the assumption of quadratic utility; however, it is quite stringent and, in most contexts, highly implausible (Blanchard and Mankiw, 1988: 173).

The assumption of quadratic utility is unappealing, since in describing consumers’ behavior towards risks, it implies increasing absolute risk aversion (IARA); that is, a willingness to pay more to avoid a given bet as wealth increases\textsuperscript{32}. As we have seen, the assumption of quadratic utility is the source of certainty equivalent behavior: the utility cost of a given variance of consumption is independent of the level of consumption. This means that, since the marginal utility of consumption is declining, individuals have increasing absolute risk aversion: the amount of consumption they are willing to give up in order to avoid a given amount of uncertainty concerning the level of consumption rises as they become wealthier. This would seems to suggest that marginal utility ideally should fall more slowly as consumption rises, the third derivative of the utility function therefore should be positive rather than zero (Romer, 2006: 372).

With a poor description of behavior under the uncertainty of the quadratic utility function, two main utility functions, which are more attractive, were implemented; that is, the exponential utility function, which exhibits constant absolute

\textsuperscript{31} Campbell’s (1987: 1249-1273) famous rainy day saving motive shows that the permanent income hypothesis implies that people save because they rationally expect their permanent income to decline.

\textsuperscript{32} In other words, IARA also implies that as households experience an increase in wealth, they will choose to decrease the number of dollars of risky assets held in the portfolio.
risk aversion (CARA), and the isoelastic utility function, which exhibit constant relative risk aversion (CRRA)\textsuperscript{33}. Both utility functions are non-increasing absolute risk aversion, and there is the positive third derivation of the utility function and convexity in marginal utility\textsuperscript{34}.

The property of the positive third derivative of the utility function dramatically changes in consumers’ behavior. According to the Euler equation (13), as we know, if utility is quadratic, marginal utility is linear, and it has zero third derivatives. Then we have:

\[
E_t[U'(C_{t+1})] = U'[E_t(C_{t+1})],
\]

which implies that uncertainty will not affect marginal utility or consumption. However, if we apply a CARA utility function in the following form:

\[
U(C_t) = \frac{1}{\alpha} \exp(\alpha C_t) , \quad \alpha > 0 ,
\]

so that\textsuperscript{35}

\[
U'(C_t) = \exp(-\alpha C_t) > 0 ,
U''(C_t) = \alpha \exp(-\alpha C_t) < 0 ,
U'''(C_t) = \alpha^2 \exp(-\alpha C_t) > 0 ,
\]

\textsuperscript{33} The isoelastic utility function is also called the constant elasticity of substitution utility function (CES).

\textsuperscript{34} Actually both of quadratic utilities: CARA as well as CRRA, are most of commonly used utility functions which is the class of function, which exhibits Hyperbolic Absolute Risk Aversion (HARA). However, Carroll and Kimball (1996: 981-992) prove that, without the presence of liquidity constraints, the consumption function will be concave in the HARA class of utility functions, with quadratic utility function as its exceptions.

\textsuperscript{35} The coefficients of absolute risk aversion can be obtain by applying the Arrow – Pratt risk aversion measure:

\[
R_A = -\frac{U''(C)}{U'(C)} = \left[ \frac{-\alpha \exp(-\alpha C)}{\exp(-\alpha C)} \right] = \alpha.
\]
where $\alpha$ is the coefficient of absolute risk aversion. We then have the positive third
derivative utility function and marginal utility is a convex function of consumption.

Similarly, if we apply a CRRA utility function in the following form:

$$
U(C_t) = \begin{cases} 
\frac{1}{1-\gamma} C_t^{1-\gamma}, & y \neq 1 \\
\ln(C_t), & y = 1 
\end{cases},
$$

so that

$$
U'(C_t) = C_t^{-\gamma},
$$
$$
U''(C_t) = \gamma C_t^{-\gamma-1},
$$
$$
U'''(C_t) = \gamma(\gamma + 1) C_t^{2+\gamma},
$$

where $\gamma$ is the coefficient of relative risk aversion ($> 0$) and the inverse of the
intertemporal elasticity of substitution$^{36}$. We then have the same two properties as the
CARA.

Therefore, if we apply either CARA or CRRA, which has the properties of the
positive third derivative and convexity in marginal utility on the Euler Equation (20),

Then equation (20) become$^{37}$:

$$
E_t[U'(C_{t+1})] > U'[E_t(C_{t+1})].
$$

That is, the expected marginal utility of consumption is greater than the
marginal utility of expected consumption. But as we know, at the optimal:

$^{36}$ By applying the Arrow – Pratt risk aversion measure:

$$
R_R = \frac{-CU''(C)}{U'(C)} = -C \left[ \frac{-\gamma C}{C - \gamma} \right] = \gamma.
$$

$^{37}$ Due to Jensen’s inequality which states that for a convex function $f$, if $x \in [0,1]$, then

$$
\lambda f(x) + (1-\lambda) f(y) \geq f(\lambda x + (1-\lambda) y),
$$

thus we can also generalize the result to expectation as

$$
E[f(x)] \geq f(E[x]).
$$
\[ C_t = E_t(C_{t+1}), \]  

then

\[ U'[E_t(C_{t+1})] = U'(C_t). \]  

Therefore, equation (23) becomes:

\[ E_t[U'(C_{t+1})] > U'(C_t), \]

which implies that consumption smoothing would not be optimal. A marginal reduction in \( C_t \) would then restore the equality in equation (26). The reduction in current consumption and increase in savings as a result of the positive third derivative and uncertainty about future income are known as precautionary savings (Romer, 2006: 372).\(^3\)

As with the Arrow Pratt coefficients of risk aversion, that has been used to measure the degree of risk aversion, the degree of precaution can be measured by a coefficient of absolute and relative prudence (Kimball, 1990: 53-73).\(^4\) However, note that these coefficients do not provide a sensible way to present the effect of future income uncertainty on consumption and savings. To model this relationship, therefore, optimal consumption needs to be solved.

Unfortunately, once we move beyond a certainty equivalent, finding the closed form solutions which characterize optimal consumption is very difficult. Over the past two decades, several authors nonetheless have attempted to solve a closed form solution for the consumption function with ingenious techniques, for example, Zeldes (1989 a): 275-298) used a numerical method, Skinner (1988: 237-255) approximated the consumption path by solving for the second-order Taylor series expansion of

\(^3\) The first papers on this subject were developed by Leland (1968: 465-473); Sandmo (1970: 353-360) and Dreze and Modigliani (1972: 308-335).

\(^4\) Similar to the Arrow – Pratt coefficients of risk aversion measure of the effects of uncertainty on expect utility, the coefficients of absolute and relative prudence measure the effects of uncertainty on expected marginal utility and thus on consumption. The coefficient of absolute prudence is defined as \(-U'''/U''\), while the coefficient of relative prudence as \(-CU'''/U''\).
the Euler equation, and Caballero (1990: 113-136) chose a specific utility function and income-generation process. The form of those solutions thus depends on assumptions about the stochastic process for income and for the rate of return, including on the form of the utility function.

(A.) Optimal Consumption with the CARA Utility

Since it has tractability, the CARA utility has been chosen by several authors. This include Merton (1971: 373-413); Caballero (1990: 113-136) and (1991: 855-871); Kimball and Mankiw (1989: 863-879); Dardanoni (1991: 153-160); and Wang (2004: 1645-1681).

Base on Caballero’s approach (1990: 113-136) and (1991: 859-871), which assume consumers live for \( T \) years, interest and discount rate are constant and equal to zero. The consumer’s optimization problem thus is

\[
\begin{align*}
\text{Max} & \quad E \left[ \sum_{i=0}^{T-i+i} \frac{1}{\alpha} \exp(-\alpha C_{t+i}) \right] \\
\text{subject to} & \\
C_{t+i} &= Y_{t+i} + A_{t+i-1} - A_{t+i}, \\
\lim_{i \to \infty} A_{t+i}(1+r)^{-i} &= 0, \\
A_{t-1} & \text{ given.}
\end{align*}
\]

Additionally, assuming labor income follows a random walk with normally distributed shocks (innovations to income)

---

40 Beyond the certainly equivalent, the derivation of a closed form solution is very difficult (Blanchard and Mankiw, 1988: 173-177). Caballero’s approach is one of the ingenious techniques, but unfortunately Caballero (1990: 113-136) does not explicitly exhibit his derivation. Thus, the derivation in this study highly depends on Blanchard and Fisher (1989) as well as Hibbs (2004:1-17).
\[ Y_{t+i} = Y_{t+i-1} + \varepsilon_t, \quad \varepsilon_t \sim \text{Normal}(0, \sigma^2), \]  

(30)

and suppose the uncertainty about \( C_{t+i} \) is such that it is perceived to have a normal distribution with mean \( E_t(C_{t+i}) \) and variance \( \sigma^2 \):

\[ C_{t+i} \overset{\text{i.i.d.}}{\sim} \text{Normal}(\mu, \sigma^2), \]  

(31)

applying a useful result from statistic (known as moment-generating function) is that if a variable \( x \) is normally distributed and has mean \( \mu \) and variance \( \sigma^2 \):  

\[ E_t[\exp(-\alpha C_t)] = \exp[E_t(-\alpha C_{t+1}) + \frac{1}{2} \text{Var}(-\alpha C_{t+1})], \]  

(32)

then we get

\[ E_t[\exp(-\alpha C_{t+1})] = \exp[E_t(-\alpha C_{t+1}) + \frac{1}{2} \alpha^2 \sigma^2], \]  

(33)

\[ = \exp[E_t(-\alpha C_{t+1}) + \frac{1}{2} \alpha^2 \sigma^2]. \]  

(34)

Therefore, the Euler equation (32) can be written as

\[ \exp[E_t(-\alpha C_{t+1}) + \frac{1}{2} \alpha^2 \sigma^2] = \exp(-\alpha C_t). \]  

(35)

Taking the logs of both sides on equation (35) yields:

---

41 If \( x \) is a log normal variable which is normally distributed with mean \( E(x) \) and variance \( \sigma^2 \), then  

\[ E[\exp(x)] = \exp[E(x) + \frac{1}{2} \sigma^2], \]  

\[-\alpha E_t(C_{t+1}) + \frac{1}{2} \alpha^2 \sigma^2 = -\alpha C_t, \quad (36)\]

\[E_t(C_{t+1}) = C_t + \frac{1}{2} \alpha \sigma^2, \quad (37)\]

or equivalent to

\[C_{t+1} = C_t + \frac{1}{2} \alpha \sigma^2 + e_{t+1}, \quad e_{t+1} \sim 0, \text{ white noise.} \quad (38)\]

Iterating one finds:

\[C_{t+i} = C_t + i \left( \frac{1}{2} \alpha \sigma^2 \right) + \sum_i e_{t+i}, \quad (39)\]

\[E_t(C_{t+i}) = C_t + i \left( \frac{1}{2} \alpha \sigma^2 \right), \quad i = 0, 1, \ldots, T-t. \quad (40)\]

This means that the larger the variance of innovations to income, \(\sigma^2\), and the greater the coefficient of relative prudence, \(\alpha\), the more upward sloping the optimal consumption plan will be, and the greater will be the precautionary savings early in life.

Using then the income process in the form:

\[Y_{t+i} = Y_{t+i-1} + \varepsilon_{t+i}, \quad i \geq 0, \quad (41)\]

and thus implies that
\[
Y_{t+i} = Y_t + \sum_{i=1}^{T-t} \varepsilon_{t+i}, \quad (42)
\]

then rewrites the intertemporal budget constraint under uncertainty case as

\[
\sum_{i=0}^{T-t} C_{t+i} = A_t + \sum_{i=0}^{T-t} Y_{t+i}. \quad (43)
\]

Substituting (40) and (42) into (43) yields:

\[
(T-t+1) \cdot C_t + \sum_{i=0}^{T-t} i \cdot \left( \frac{1}{2} \alpha \sigma^2 \right) = A_t + (T-t+1) \cdot Y_t + \sum_{i=0}^{T-t} \varepsilon_{t+i}, \quad (44)
\]

\[
(T-t+1) \cdot C_t + \sum_{i=0}^{T-t} i \cdot \left( \frac{1}{2} \alpha \sigma^2 \right) = A_t + (T-t+1) \cdot Y_t. \quad (45)
\]

rearranging then equation (45) becomes:

\[
C_t = \frac{1}{(T-t+1)} \left[ A_t + (T-t+1) \cdot Y_t - \sum_{i=0}^{T-t} i \cdot \left( \frac{1}{2} \alpha \sigma^2 \right) \right], \quad (46)
\]

\[
C_t = \frac{1}{(T-t+1)} A_t + Y_t - \frac{1}{(T-t+1)} \sum_{i=0}^{T-t} i \cdot \left( \frac{1}{2} \alpha \sigma^2 \right). \quad (47)
\]

Using the fact that

\[
\frac{1}{(T-t+1)} \sum_{i=0}^{T-t} i \cdot \left( \frac{1}{2} \alpha \sigma^2 \right) = \frac{1}{2} (T-t) \left( \frac{1}{2} \alpha \sigma^2 \right), \quad (48)
\]

\[
= \frac{1}{4} (T-t) \alpha \sigma^2, \quad (49)
\]
Finally, we get:

$$\frac{C}{t} = \frac{1}{(T-t+1)} A_t + \frac{1}{4}(T-t)\alpha \sigma^2, \quad (50)$$

which implies that current consumption depends on the certainty equivalent plus a precautionary element, which depend on the income uncertainty \((\sigma^2)\) and prudence \((\alpha)\)^42.

(B.) **Optimal Consumption with the CRRA Utility**

Even though the CARA utility is tractable, it is somewhat unattractive: (i) the optimal consumption profile allows for negative consumption values; (ii) high-income and low-income households have the same marginal propensities to consume but different average propensities to consume; and (iii) the intertemporal elasticity of the substitution for the utility function does not exist (Irvine and Wang, 1994: 1464). In contrast, the CRRA utility is much more realistic than both the quadratic and CARA utilities (see discussion in Blundell and Stoker, 1999: 475-507); even obtaining a closed-form solution is generally impossible except when applied with some techniques, for example, Skinner, 1988: 237-255 and Zeldes, 1989 (a): 275-298). Currently, since it is a more attractive utility function, several studies of precautionary savings choose the CRRA utility. These include Kimball (1990: 53-74), Carroll (1994: 111-148), Hubbard, Skinner and Zeldes (1995: 360-399), Carroll and Samwick (1997: 41-71).

To see how the optimal consumption with the CRRA utility is different from the CARA case, we brief Skinner’s approach (1988: 237-255), where the optimal consumption is approximated by solving for the second-order Taylor-series expansion of the Euler condition.

With the expected lifetime utility:

$$EU = E\left\{ \sum_{i=1}^{D} (1+\bar{\delta})^{1-i} U(C_i) \right\}, \quad (51)$$

^42 Note that if \(\alpha = 0\) in equation (50), the optimal consumption follows the standard version of the LC/PIH.
The utility maximization problem can be written as a standard dynamic programming problem:

\[
V(W_i, S_i) = \max_{C_i} \left\{ U(C_i) + (1 + \delta)^{-1} E_i \left[ V(W_{i+1}, S_{i+1}) \right] \right\},
\]

where \( V(W_i, S_i) \) is the value function which depend on financial wealth \( W_i \) at age \( i \) and a vector of age and occupation specific state variables \( S_i \), and current wealth is

\[
W_i = (W_i - C_{i-1})(1 + r_i) + Y_i,
\]

where \( Y_i \) represents earning and \( r_i \) the net interest rate.

The first-order condition for (52) subject to (53) is written\(^4\):

\[
U''(C_i) = E_i \left[ \frac{1 + r_i + 1}{1 + \delta} \right] V''(W_{i+1}, S_{i+1}) \right\}.
\]

Because expanding the model to include interest rate uncertainty and multi-period consumption requires more structure and leads to greater analytical complexity. Skinner assumed four assumptions that facilitate the derivation of the closed-form solution (Skinner, 1988: 241-242), and one of these is the CRRA utility

\[
[U(C_i) = C_i^{1-\gamma} / (1 - \gamma)].
\]

Combining stochastic asset return and labor income, and the CRRA utility assumption, the optimal consumption is approximated by solving for the second-order Taylor-series expansion of the Euler equation (54) as follows\(^4\):

\(^4\) Equation (54) is, in general, intractable, and most studies have used numerical to solve it (see this method in Zeldes (1989: 275-98)).

\[ \Delta C_i = \ln \frac{C_i}{C_{i-1}} = \frac{1}{\gamma} \left[ -r - \delta - v_i \right] + \ln \left[ \frac{L_i}{L_i} \right], \quad (55) \]

where

\[ v_i = \theta_1 \sigma^2_y + \theta_2 \sigma^2_r + \theta_3 \sigma_{ry}, \]

which is known as the uncertainty premium composed of variance of income \( (\sigma^2_y) \), variance of interest rate \( (\sigma^2_r) \), and their covariance \( (\sigma_{ry}) \). \( \bar{r} \) is the expected interest rate. \( L_i \) is the permanent income level which is the present value of lifetime resources at the end of period \( i \), and \( L_i = E_{i+1} [L_i] \) is the anticipated present value of resources at age \( i \), given information at \( i = 1 \). The last term then represent the revision of lifetime resources as new innovation arrives.

### 2.2.2 Liquidity Constraint

Liquidity constraints have frequently been stated to be another empirical failing of the standard version of the LC/PIH. The standard version of the LC/PIH assumes that households can borrow at the same interest rate at which they can save as long as they eventually repay their loans. However, the borrowing interest rate is generally much higher than the saving interest rate. Furthermore, some households are unable to borrow more at any interest rate.

Liquidity constraints can raises (lower) savings (consumption) in two ways (Romer, 2006: 375). First, and most obviously, wherever a liquidity constraint is binding, it causes households to consume less than they would. This has been simply proved by assuming a situation where there are borrowing constraints such that \( A_{i} \geq 0 \) which can implies \( C_i \leq (Y_i + A_i) \). Applying the Kuhn-Tucker first order condition, which combines a Kuhn-Tucker multiplier \( (\lambda_i) \) with this constraint and assumes then \( r = \delta = 1 \) for simplicity. The usual Euler equation (13) can be written as
Equation (56) shows that if the constraint is binding \((\lambda_t > 0)\), then the marginal utility of consumption would have to be greater than in the unconstrained optimum, and current marginal utility is greater than future marginal utility, which implies that current consumption is too low due to borrowing constraints, or in other words, consumption is lower if the constraint binds.

Second, as Zeldes (1989 (b): 314) has emphasized, even if the current constraint is not binding, so that the Euler equation between \(t\) and \(t+1\) is satisfied, the presence of constraints that will bind in the future with some positive probability will lower the current consumption of any risk-averse household. To see this point more clearly, consider the Euler equation for the next period:

\[
U'(C_{t+1}) = E_{t+1}[U'(C_{t+2})] + \lambda_{t+1}.'
\]  

(57)

Take the expectation given the information in period \(t\):

\[
E_t[U'(C_{t+1})] = E_{t+1}[U'(C_{t+2})] + E_t(\lambda_{t+1}),
\]  

(58)

where we have used the law of iterated expectations. Substituting this back into the standard Euler equation yields:

\[
U'(C_t) = E_t[U'(C_{t+2})] + E_t(\lambda_{t+1}).
\]  

(59)

Therefore, if there is a probability that constraints will bind in the future, \(E_t(\lambda_{t+1} > 0)\), current consumption will be lower than it would have been without liquidity constraints, even if the standard Euler equation holds.

Finally, before we move to the next section, it should be noted that in the presence of non-quadratic preference and liquidity constraints, a rise in future income
uncertainty can lead to a lower current consumption and a rise in current savings\(^{45}\). Thus, once we move beyond certainty equivalence, consumption not only depends on permanent income as in traditional models of consumption, but also there are additional variables, such as the income uncertainty.

As seen in the literature on testing of the standard version of the LC/PIH, a large number of studies about precautionary savings and liquidity constraints have appeared due to the failing of the standard version of the LC/PIH, which cannot explain why the marginal propensity to consume out of transitory income shocks is unequal to zero. In contrast, this failure can be explained by precautionary savings and the liquidity constraint model, which state that households will not fully smooth their transitory shocks. Instead, their consumption may drop in the face of transitory income shocks in order to preserve their buffer stocks against the possibility of future shocks (Kazianga and Udry, 2006: 433). However, even though both models are very closely connected, most empirical literature clearly separates both models. Here thus we first review the literature about precautionary savings and followed by liquidity constraints.

In spite of the fact that the literatures that explains the idea that people engage in precautionary saving motive dates back to Friedman in 1957, and later modeled by Leland (1968: 465-437), the empirical literature, which concerns the importance of precautionary savings, was developed in the 1980 decades. Skinner (1988: 237-255) uses the 1972 – 1973 Consumer Expenditure Survey and proxies income uncertainty by occupation. He found nevertheless little evidence for precautionary savings. Coballero (1990: 113-136, 1991: 859-871) used the exponential utility function as a parameterization of within-period utility obtains, with some additional assumptions, a closed form solution consumption. He then went on to evaluate the effect that precautionary savings is likely to have in reality. Dardanoni (1991: 153-160) derived a closed-form solution consumption and used cross-sectional data from the 1984 UK Family Expenditure Survey. His results revealed that variance of labor income have a significant effect on total expenditures. Guiso, Jappeli, and Terlizzese. (1992: 307-

\(^{45}\) There is very close connection between the precautionary savings and liquidity constraints. In either case, we would observe current consumption (savings) being especially low (high) for those households, which anticipate a higher variance of consumption in the future (Kazianga and Udry, 2006: 433).
tested the presence of precautionary savings using the households’ subjective assessment of uncertainty drawn from the 1989 Italian Survey of Household Income and Wealth. They found that precautionary savings explained only 2 percent of households’ net worth.

Dynan (1993: 1104-1113) used the 1985 Consumer Expenditure Survey and found a precautionary motive that was too small and inconsistent with plausible risk aversion parameters. Meanwhile, the failure to find a strong precautionary motive cannot be explained by either liquidity-constrained households or self-selection of households into risky environments. Carroll (1994: 111-147, 1997: 1-55) had strongly supported the existence of the precautionary savings through a buffer stock saving model. He found that future income uncertainty has an important effect: consumers with greater income uncertainty, ceteris paribus, have lower current consumption. Lusardi (1997: 319-326) used the subjective data on earnings variance provided in the Italian Survey of Household Income and Wealth and found that the coefficient of the subjective earnings variance was statistically significant and precisely estimated. However, the estimated coefficient was small. Kazarosian (1997: 241-247) tested for the precautionary motive for savings using panel data and found a strong precautionary motive that was a doubling of uncertainty increased the ratio of wealth to permanent income by 29 percentage. Miles (1997: 1-25) used the UK micro data to estimate the determinant of household income and to measure how permanent income and earnings uncertainty affect consumption. He found that earnings uncertainty as well as permanent income had powerful effects on spending. His results showed also that doubling income variability for the typical household reduced consumption by, on average, almost 5%.

Lusardi (1998: 449-453) used a new data set from the Health and Retirement Study (HRS), which provide data on the subjective probabilities of job loss as an income variance proxy. The empirical results showed that even though the sign of the variance of income was positive and statistically significant, the size of coefficient was still quite small. Carroll and Samwick (1998: 410-419) regressed households’ wealth on their measures of uncertainty by using the Panel Study of Income Dynamic, and found substantial evidence that households engage in precautionary savings. Pistaferri (2001: 465-476) tested whether households save for a rainy day using data
available for a panel of Italian households drawn from the 1989 – 1991 Bank of Italy Survey of Household Income and Wealth. He found the empirical evidence that supported and extended the version of the PIH; that is, savings do respond to transitory income shocks, but also to permanent income shocks and higher moments of the distribution of earnings. Chen, Meilke and Turvey (1999: 173-183) used panel data from Illinois grain farmers to test directly the relationship between income risks and farm consumption. Their estimation results revealed that income risks significantly affect farm consumption, and these results were also robust using alternative risk measures. Engen and Gruber (2001: 545-579) tested for the precautionary motive by estimating the crowding out effect of Unemployment Insurance (UI) on financial assets using household-level data from the Survey of Income and Program Participation (SIPP). Their empirical results were consistent with the predictions of the model and suggested that reducing the UI benefit replacement rate by 50 percent would increase gross financial asset holding by 14 percent, or 214 U.S dollars, for the average worker.

Irvine and Wang (2001: 233-258) modeled household as having a pure retirement phase in their lifecycle as being impatient and prudent. They found that greater income uncertainty induces individuals to save greater amounts early in their lifecycle, but that there was a reversion in saving patterns later in the work life. As a result, earnings uncertainty has a significant impact upon the savings pattern over the lifecycle, in addition to its impact on the overall level of wealth in the economy. Similar to Mlies (1997: 1-25), who used household data from U.K., Guariglia (2001: 619-634) used the British Household Panel Survey (BHPS) to test the precautionary saving hypothesis. Apart from adopted Lusardi’s (1998: 445-453) measurement of earnings uncertainty, she constructed three additional household-specific measures of earning uncertainty. Her results show that various measures of uncertainty based on earnings variability have a statistically significant effect on a household’s saving decisions. Chou, Liu and Hammitt (2003: 1873-1894) examined the impact of National Health Insurance on households’ precautionary savings using Taiwan micro-data beginning with the 1995 introduction of National Health Insurance. They found that compared with the preceding government insurance programs, National Health Insurance reduced savings by an average of 8.6-13.7 percent, with the largest effects
on households with the smallest savings. Meng (2003: 465-485) tested both the PIH and precautionary saving motives using data from urban China. He used two-stage estimations by estimating first the probability of each household laborer being unemployed and then used the estimated average household probability of being unemployed to construct permanent and variance income. He found that households were able to smooth their total consumption and food consumption but not education expenditures. He found also that households in urban China have strong precautionary saving motives, especially with regard to the prospect of some members facing unemployment.

Zhou (2003: 192-212) improved upon Dardanoni’s (1991: 153-160) approach of measuring earnings uncertainty by creating dozens of homogeneous groups and regarding income variance with each group as the approximate income uncertainty of individuals in that group. By applying this technique with Japanese households, he found that income uncertainty had a negative significant impact on household consumption in most groups of households. Additionally, he found also that precautionary savings may account for 5.56% and 64.30% of the total savings of salaried worker households and agricultural, forestry, fisheries, and self-employed households respectively. Guariglia and Kim (2004: 289-310) investigated the precautionary saving hypothesis using a panel Russian households. Like Lusardi (1998: 445-453), they proxied uncertainty with a measure of earning uncertainty based on the subjective probability of primary job loss of household heads. Their results revealed that earning uncertainty generally has a strong positive effect on savings even if there was robustness with different estimation techniques. However, this positive effect of uncertainty on savings was weaker for multiple-earner households and the reverse for households whose head held more than one job.

Kazianga and Ury (2006: 413-446) investigated patterns of consumption smoothing between 1981 and 1985 by rural households in Burkina Faso. They found little evidences of consumption smoothing either over time or across households within villages. In addition, they extended the PIH model by including the variance of income and the coefficient of variation to test for precautionary savings. The results showed that both the variance of income and the coefficient of variations had significant effect on household saving. Ventura and Eisenhauer (2006: 155-168)
developed a model of savings with an explicit role for the LeLand-Kimball measure of precedence. They then estimated the model using household-level data from Italy and found that income risks had low, significant impact on savings. In addition, they found an average value of relative prudence near 4 or 5, with approximately 15-35 percent of total savings being precautionary. Bessho and Tobita (2008: 303-325) used the 1997 wave of Nikkei Radar micro data on Japan households and employed job loss rate as a measure of risks. Their empirical results indicated that uncertainty had a positive and statistically significant effect on the wealth to income ratio, and buffer-stock savings accounted for 6 or 15 percent of net financial assets. Utilizing data from the Korean Household Panel Study (KHPS), Kong; J.Y. Lee and H.K. Lee (2008: 76-79) developed a stochastic dynamic model within the health capital framework to obtain a closed-form solution characterizing a retired individual’s precautionary behavior under health uncertainty. By using the equation from their derivation, they found that elderly households were found not only to reduce their current consumption but also raised current expenditures on medical care in the face of growing uncertainty about future health outcomes.

As with the literature on precautionary savings, the literature on the effect of liquidity constraints on savings and consumption is fruitful. Zeldes’s work (1989 (b): 305 – 346) is one of the primary works for testing for liquidity constraints. He used the Panel Study of Income Dynamics (PSID), and used Euler equation tests, which assumed the utility function is of the CRRA form. He then split the observations into two groups according to the wealth /income ratio and examining the behavior of the groups though the Euler equation estimation. The results generally supported the hypothesis that borrowing constraints affects the consumption of a significant portion of the population. Hayashi (1985: 183-206) examined the effect of liquidity constraints on consumption expenditures using a single-year cross-section data set. The saving rate was used as the criterion for separating unconstrained from constrained consumers. He found evidences supporting the validity of liquidity

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constraints. Langemeier and Patrick (1993: 479-484) used 1976 to 1990 data for groups of Illinois and Kansas forms. The results showed that farm family consumption was not liquidity constrained. Bayoumi (1993: 536-539) use regional data to investigate the connection between consumption and financial deregulations. The results indicated that deregulation has led to a significant increase in the forward-looking nature of aggregate consumption.

Jappelli and Pagano (1994: 83-109) examined the effect of liquidity constraints on savings and growth using cross-country regression. They found that liquidity constraints on households: (i) raised the saving rate, (ii) strengthened the effect of growth on savings, (iii) increased the growth rate if the productivity growth was endogenous, and (iv) may increase welfare. Bacchetta and Gerlach (1997: 207-238) investigated the hypothesis that if some consumers were liquidity-constrained, aggregate consumption should be “excessively sensitive” to credit conditions as well as to income. Using data from the U.S, Canada, the United Kingdom, Japan, and France, they found a substantial impact of credit aggregates on consumption in all countries considered. Moreover, the borrowing/lending wedge was a significant determinant of consumption in U.S., Canada, and Japan. DeJuan and Seater (1999: 351-376) using the 1986-1991 the US, Consumer Expenditure Survey data without creating a synthetic panel. Their results supported the permanent income/life cycle hypothesis, and there was little evidence of liquidity-constrained or rule-of-thumb behavior, and these results were robust with respect to consumption category, change in samples, and choice of instruments.

Girardin, Sarno and Taylor (2000: 351-368) examined the effect of financial deregulations on consumption expenditures in France during the period 1970 to 1993. They found that financial deregulations have significantly reduced liquidity constraints faced by consumers, allowing a higher percentage of the population to smooth consumption over time. Madsen and Mcaleer (2000: 229-252), using direct expectation data based on the University of Michigan Surveys of Consumers data, tested for the excess sensitivity of consumption to current income. The empirical estimates indicated that consumption was not sensitive to current income when the influences of uncertainty, in particular, and also credit constraints were accommodated in the model. Thus, the theoretical predictions of the rational
expectations LC/PIH were unfounded empirically because they failed to accommodate uncertainty, in particular, and credit constraints. Filer and Fisher (2007: 790-805) used bankruptcy information from the Panel Study of Income Dynamics (PSID) to split the sample of households into those that were liquidity-constrained from those that were likely unconstrained, and then examined whether liquidity constraints generated excess sensitivity in consumption. They found that post-bankruptcy consumers exhibiting excess sensitivity was likely due to the bankruptcy flag.

Finally, since it was mentioned earlier that there is a close relationship between precautionary savings and liquidity constraints, thus before we end in this section, a few studies about this relationship will be also reviewed. Carroll and Kimball (2001: 1-40) developed a rigorous theory and a numerical analysis to explain the relationship between liquidity constraints and precautionary savings. They indicated that when a liquidity constraints were added to the standard consumption problem, the results value function exhibits increased prudence around the level of wealth where the constraint bound. Nevertheless, they showed that the introduction of further borrowing constraints did not necessarily lead to an increase in precautionary savings. Fernandez-Corugedo (2002: 1-38) examined the relationship between precautionary savings and soft liquidity constraints. He found that the introduction of soft constraints did not lead to behavior that was fundamentally different under hard constraints, but soft-constrained consumers had lower levels of precautionary savings than hard constrained consumers. Lee and Sawada (2010: 77-86) examined the relationship between liquidity constraints and precautionary savings using household panel data from rural Pakistan. They found substantial evidence for the presence of precautionary savings in there. Additionally, their results showed that

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47 At least since Zeldes (1984), economists working with numerical solutions have known that liquidity constraints could induce precautionary savings even under the quadratic utility function, which rules out precautionary savings (Carroll and Kimball, 2001: 3).

48 Soft liquidity constraints mean that the case of households is allowed to borrow, but face penalties that increase with the amount borrowed (Fernandez-Corugedo, 2002: 7).
the estimated prudence for liquidity constrained households was significantly higher than unconstrained ones.
CHAPTER 3

METHEODOLOGY

Since the consumption theory in the previous section was described as a general concept, it thus needs more specificity for theory testing. To achieve this objective, this section presents three main components of the test on the consumption theories: empirical specifications, econometric techniques, and data description.

3.1 Empirical Specifications

To implement an empirical test for the LC/PIH, we need to develop an empirical consumption model. Because this study’s model nonetheless is constructed based on the theoretical background in the previous section, several processes need to be described.

As with the development of consumption theories, we start with the standard version of the LC/PIH. According to this standard version, a household’s consumption is determined by two main factors: permanent income and life cycle factors. The model thus is firstly specified as

$$C_{itr} = \beta_0 + \beta_1 Y_{itr}^p + \beta_2 L_{itr} + \epsilon_{itr},$$  

where $C_{itr}$ is consumption of farm household $i$ in region $r$ at time $t$, $Y_{itr}^p$ is permanent income, $L_{itr}$ is the life-cycle factors which are presented in the form of the number of household members in each of five age categories that follow Paxson’s paper (Paxson, 1992: 17), and $\epsilon_{itr}$ is an error term.
However, because one of the main objectives of this study is the study of how farm households smooth their consumption in response to transitory income shock, transitory income \(Y_{it}^T\) thus should also be included in the model. Furthermore, this study also includes idiosyncratic shock \(IS_{irt}\) to examine how well households smooth their consumption when they face shocks other than income shocks. In addition, since panel data are used, the household fixed effect \(\lambda_i\) should be included to capture unobservable household characteristics\(^{49}\). Therefore, regarding these variables, equation (60) may be rewritten as

\[
C_{irt} = \beta_0 + \beta_1 Y_{irt}^P + \beta_2 Y_{irt}^T + \beta_3 L_{irt} + \beta_4 IS_{irt} + \lambda_i + \epsilon_{irt}.
\]  

(61)

At this point, the challenge of most studies about consumption smoothing is how it measures permanent and transitory income and how it separates idiosyncratic and aggregate transitory shocks. This study uses a different approach to each component in the model.

To measure permanent and transitory income, we modified the study of Fafchamps, Udry and Czukas (1996: 273-305); Kazianga and Udry (2006: 413-446) and Jacoby and Skoufias (1997: 311-335), which take a similar approach, but are different in details. All of these start with setting the income equation of the form:

\[
Y_{irt} = \alpha_1 X_{irt} + \alpha_2 R_{irt} \otimes Q_{irt} + \gamma_{irt} + \lambda_i + u_{irt}.
\]  

(62)

If we nevertheless define \(\gamma_{irt} = \alpha_r R_{irt} + \gamma_{irt}\), and assume that \(\gamma_{irt}\) is uncorrelated with \(X_{irt}\) and \(Q_{irt}\). We then can rewrite equation (62) as\(^{50}\)

\[
Y_{irt} = \alpha_1 X_{irt} + \alpha_2 R_{irt} \otimes Q_{irt} + \alpha_3 R_{irt} + \lambda_i + (\gamma_{irt} + u_{irt}),
\]  

(63)

\(^{49}\) Beegle, Dehejia and Gatti (2006: 83) indicated that including household fixed effects also implies that income shocks are measured relative to a household level, as well as implying that we are examining the effect of idiosyncratic shocks after aggregate and that non-time varying household risk factors have been purged.

\(^{50}\) Equation (63) is less general than (62), but it permits us to examine the impact of aggregate (village level) rainfall shocks on consumption and saving choices (Kazianga and Udry, 2006: 426).
where $Y_{it}$ is the household income, $R_{it}$ is the deviation of rainfall from the long-run regional mean and this deviation squared, $Q_{it}$ is the farm characteristics that are determinants of income, such as the demographic structure of the households and detailed information on its landholdings and their quality (Fafchamps, Udry and Czukas, 1996: 288), $\gamma_{it}$ is a village-year fixed effect, and $u_{it}$ is a random component consisting of the unobserved factors affecting income changes and measurement error. The Kronecker product ($\otimes$) generates an interaction terms.

From equation (63) we may divide total income (farm profit plus nonfarm income) into three types following Kazianga and Udry (2006: 426) and Fafchamps, Udry and Czukas (1996: 288).

The permanent income is defined as

$$Y^P_{it} = \hat{\alpha}_1 X_{it}. \tag{64}$$

The transitory income is defined as

$$Y^T_{it} = \hat{\alpha}_2 R_{it} \otimes Q_{it} + \hat{\alpha}_3 R_{it}. \tag{65}$$

An unexplained income is

$$u_{iit}$$

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51 Permanent income may be measured with several approaches. For example, Musgrove (1979: 355-68) estimated permanent income as a function of age, education and occupation; Bhatta (1980: 722-43) measured permanent income based on estimates of an earnings equation and base on a weighted average of past income; Alderman (1996: 343-65) measured permanent income by using the average 3 year’s coefficient of the income predicted. Similar to the study of Paxson (1992: 15-33), we are most concerned with whether households smooth consumption in response to short-term shocks to income; therefore, we use a short-term horizon, as expected income for year $t$ conditional on resources (and information) of the household at the beginning of the period, when defining permanent income rather than defining permanent income as the annuity value of lifetime wealth used in the life-cycle model.

52 Before Paxson’s (1992: 15-33) work was developed, most studies measured transitory income as a residual (income minus estimated permanent income).

53 Since $y^U_{iit}$ is the sum of the error terms from both the permanent and transitory income equations, estimates of $y^U_{iit}$ are likely to contain both permanent and transitory components. Within the context of a permanent income framework, this implies that the propensity to save out of unexplained income will exceed the propensity to save out of measured permanent income but will be less than that of measured transitory income (Paxson, 1992: 19).
After the three income components are estimated, then we may estimate the standard version of the LC/PIH by substituting these estimated income into (61):

$$C_{irt} = \beta_0 + \beta_1 \hat{Y}_{irt}^p + \beta_2 \hat{Y}_{irt}^T + \beta_3 \hat{Y}_{irt}^u + \beta_4 L_{irt} + \beta_5 S_{irt} + \lambda_i + \epsilon_{irt}. \quad (67)$$

If our objective is the study of how farm households smooth their consumption in response to transitory income shock, we then can check whether $\beta_1 = 1$ and $\beta_2 = 0$ from equation (67). Nevertheless, as we learned in the theoretical section, the standard version of the LC/PIH overlooks some crucial real-world characteristics, and to fulfill this gap thus we may extend the standard version of the LC/PIH by also looking at the effect of the precautionary saving motive in our consumption model.\(^5\)

When we concern ourselves about precautionary savings, the farm household’s consumption is related not only to the first moment but also higher moments of income, such as the variance of income. Consequently, like permanent and transitory income, the challenge of testing precautionary saving is how it measures future income uncertainty.

There are several candidate measurements for income risks that have been suggested by several authors. For example, Skinner (1988: 237-255) used the occupation of the head of the household as a proxy for risk. Guiso et al. (1992: 307-337) constructed income variance from direct survey questions. Carroll and Samwick (1998: 410-419) used the variance of income and the variance of log income from observed income processes to proxy for income risk; and, Jalan and Ravallion (2001: 23-49) constructed a measure of household-specific income uncertainty as the variance of the estimated innovation error, or the variance of the residual in the income regression. Fuerther, Engen and Gruber (2001: 545-575) used the variations of unemployment insurance as a proxy for income risk. However, there were mixed

\(^5\) This paper only concerns the precautionary saving issue but not the liquidity constraint issue. However, even though both issues may have a different testing, both issues have quit a closed relationship in the effect on savings and consumption.
results regarding the relationship between different measurement of income risks and savings (consumption); thus it is difficult to assess which is a good measure of risks.

In addition, a measure of income uncertainty also depends on the data type. Time series data have been applied widely for studying precautionary savings, for example, Caballero, 1991: 859-871, Carroll, 1992: 61-156, Ghosh and Ostry, 1997: 121-139, and Banks, Blundell and Brugiawini, 2001: 757-779. Using these data, however, cannot capture the precautionary saving behavior of individual households (Zhou, 2003: 194). A few study use cross section data due to the difficulty in erecting a measurement of income uncertainty (Dardanoni, 1991: 153-160; Zhou, 2003: 192-212). Furthermore, neglecting changes in behavior over time is one of the weaknesses of this data type. Panel data are generally an appropriate type of data for studying household behavior because they can control both household behavior and its change over time. Constructing income uncertainty with panel data thus is a good approach for studying the precautionary saving behavior of households.

This study examines the impact of transitory income and income uncertainty due to rainfall variation using three wave Thai household panel data. Unfortunately, this is short panel data. Constructing income uncertainty with short panel data may not be an appropriate approach. Nonetheless, there is solution to the problem. By applying Kazianga and Udry’s approach (Kazianga and Udry, 2006: 434), this study construct income uncertainty by estimating income variance with the time-series of rainfall variation, interacted with household land characteristics weighted by the estimates from equation (63). This formula is presented as follows:

\[
\hat{\sigma}^2(y_{irt+1}^T) = \frac{1}{16} \sum_{t=1988}^{2004} \left[ \hat{\alpha}_2 \bar{R}_{rt} \otimes \bar{Q}_{ir} + \hat{\alpha}_3 \bar{R}_{rt} \right] - \left( \hat{\alpha}_2 \bar{R}_{rt} \otimes \bar{Q}_{ir} + \hat{\alpha}_3 \bar{R}_{rt} \right)^2,
\]

(68)

where \(\hat{\sigma}^2(y_{irt+1}^T)\) is the estimated income variance, \(\bar{R}_{rt}\) is the historical rainfall data, and \(\bar{Q}_{ir}\) is the land characteristics data from sample households during panel data or
\[
\bar{Q}_{ir} = \frac{1}{3} \sum_{t=2005}^{2007} Q_{irt},
\]

assuming that households have rational expectations concerning the distribution of income shocks due to the rainfall that they can expect. We can estimate income variance by combining estimate \( \hat{\alpha}_2 \) and \( \hat{\alpha}_3 \) from equation (7) with historical rainfall and the land characteristic data as in the above explanation.

Using this measurement of income risks, equation (67) is rewritten as

\[
C_{irt} = \beta_0 + \beta_1 \hat{Y}_{irt}^p + \beta_2 \hat{Y}_{irt}^T + \beta_3 \hat{Y}_{irt}^u + \beta_4 \hat{\sigma}_{iy}^2 + \beta_5 L_{irt} + \beta_6 IS_{irt} + \lambda_i + \epsilon_{irt},
\]

where \( \hat{\sigma}_{iy}^2 \) is income risk, and according to the theory of precautionary savings, \( \beta_4 \) should be negative, indicating that households that face a higher income risk consume less and save more.

### 3.2 Econometric Techniques

Since this study use three wave Thai household panel data, the estimation techniques must be treated carefully. To understand how we can estimate equation (63) and (70), we may transform both two equations into the simple form of the unobserved effects model (UEM) (Wooldridge, 2002: 251) as

\[
y_{it} = x_{it}'\beta + a_i + u_{it}, \quad t = 1,2,\ldots,T,
\]

where \( i \) denotes the cross-sectional unit and \( t \) the time period. \( y_{it} \) and \( x_{it} \) are the explained variable and \( 1 \times K \) explanatory variables that are observable. \( a_i \) are the
variables (not a parameter) that capture all unobserved, time-constant effect which affect $y_{it}$. $u_{it}$ are the idiosyncratic errors, idiosyncratic disturbances or time-varying errors because it captures all of the unobserved factors which change across $t$ as well as across $i$ and affect $y_{it}$.

Estimating $\beta$ depends on two main assumptions:

Assumption 1:

$$E(x_{it}, a_i) \neq 0, \text{ (an endogeneity problem).}$$

Assumption 2:

$$E(x_{it}, u_{it}) = 0, \text{ (strict exogeneity).}$$

Under assumption 1 and 2, we can use the Fixed Effects (FE) or the First Differenced (FD) estimator to obtain the consistent estimator of $\beta$ allowing $a_i$ to be freely correlated with $x_{it}$. Using the OLS estimator with assumption 1 would lead to an endogeneity problem and bias of the OLS estimates.

The FE and FD estimators solve the endogeneity problem by eliminating $a_i$ from the equation with a different transformation. The FE estimator uses time – demeaning the data, while the FD estimator uses differencing the data. Therefore we may rewrite equation (68) in the form of the FE and FD estimators as

---

55 $a_i$ is also called unobserved component, latent variable, unobserved heterogeneity, individual heterogeneity and individual effect. It is included into the model to complete the model due to an omitted variable problem.

56 If strict exogeneity does not hold, FE, FD, PO and RE estimates will typically be inconsistent. However, we may be able to obtain consistent estimates by using instrument.

57 There is a traditional view of the fixed effect model which is known as the least squares dummy variable (LSDV) model. This fixed effect model can be written as

$$y_{it} = x_{it}\beta + D_i a_i + u_{it},$$

where $D_i$ is a set of individual-specific dummy variable. A common formulation of this model assumes that differences across units can be captured in differences in the constant term. Each $a_i$ thus is an unknown parameters to be estimated (see more detail in, for example, Green: 560-561 and Hsiao, 2003: 30-33).
The FE estimator (also called the within estimator) is

\[
\tilde{y}_{it} = \tilde{x}_{it} \beta + \tilde{u}_{it},
\]

(72)

where

\[
\tilde{y}_{it} = y_{it} - \bar{y}_i ; \ \bar{y}_i = \left( \sum_{t=1}^{T} y_{it} \right) / T,
\]

(73)

\[
\tilde{x}_{it} = x_{it} - \bar{x}_i ; \ \bar{x}_i = \left( \sum_{t=1}^{T} x_{it} \right) / T,
\]

(74)

\[
\tilde{u}_{it} = u_{it} - \bar{u}_i ; \ \bar{u}_i = \left( \sum_{t=1}^{T} u_{it} \right) / T,
\]

(75)

The FD estimator is

\[
\Delta y_{it} = \Delta x_{it} \beta + \Delta u_{it},
\]

(76)

where

\[
\Delta y_{it} = y_{it} - y_{it-1},
\]

(77)

\[
\Delta x_{it} = x_{it} - x_{it-1},
\]

(78)

\[
\Delta u_{it} = u_{it} - u_{it-1}.
\]

(79)

After removing \(a_i\) from the model we can estimate \(\beta\) consistently by using the OLS. However, in using these two models, the intercept and any \(x\) variables that
remain constant for each individual, such as gender, race, region etc., will drop out of the model.\textsuperscript{58}

So far, we know that if the two mains above assumption hold, we have two choices of estimators FE and FD. To decide which estimator should be used, Wooldridge (2000: 447-448) indicated that when $T = 2$, the FE and FD estimators are exactly equivalent, but when $T \geq 3$, and for large $N$ and small $T$, the choice between FE and FD is determined by the serial correlation in the idiosyncratic error $(u_{it})$. (by assuming homoscedasticity of the $u_{it}$.) If $u_{it}$ is a random walk $(u_{it} = u_{i,t-1} + \varepsilon_{it})$, then $\Delta u_{it}$ is serially uncorrelated and so the FD estimator will be more efficient than the FE estimator. Conversely, under classical assumptions, i.e. $u_{it} \sim iid (0, \sigma^2_{it})$ and $u_{it}$ are serially uncorrelated, the FE estimator will be more efficient than the FD estimator.\textsuperscript{59}

The FE and FD estimators solve the endogeneity problem by eliminating $a_i$, because it is thought to be correlated with $x_{it}$. Consequently, we can use the FE and FD estimator to obtain a consistent estimator. Nevertheless, if assumption 1 does not hold (i.e. $a_i$ is uncorrelated with $x_{it}, E(x_{it}, a_i) = 0$). Using a transformation to eliminate $a_i$ can cause in inefficient estimators.

Therefore, in the case where only assumption 2 holds, two new estimators are implemented: the Pooled OLS (PO) and the Random Effect (RE) estimator.\textsuperscript{60} To understand how these two estimators are implemented we need to define the composite error term $(v_{it})$ as

$$v_{it} = a_i + \lambda_t + u_{it},$$

\section*{Footnotes}

\textsuperscript{58} These time-constant variables can be interacted with variables that change over time and, in particular, with year dummy variables, although they cannot be included by themselves (Wooldridge, 2000: 444).

\textsuperscript{59} Since the fixed effects model is almost always stated with a serially uncorrelated idiosyncratic error, the FE estimator is used more often. However, sometimes we cannot easily compare the efficiency of the FE and FD estimators, and it is often a good idea to try both (Wooldridge, 2000: 447).

\textsuperscript{60} However, assumption 2 of the PO estimate actually is weaker than the FE, FD and RE in that rather than require a strict exogeneity assumption, the PO estimator requires $E(x_{it}, u_{it}) = 0$ ($x_{it}$ predetermined).
where $\lambda_t$ denotes the unobservable time effect, and

$$Ea_i = E\lambda_i = Eu_i = 0,$$  \hspace{1cm} (81)

$$Ea_i\lambda_i = Ea_iu_i = E\lambda_iu_i = 0,$$  \hspace{1cm} (82)

$$Ea_i\sigma_j = \begin{cases} \sigma_a^2 & \text{if } i = j, \\ 0 & \text{if } i \neq j \end{cases},$$  \hspace{1cm} (83)

$$E\lambda_i\lambda_i = \begin{cases} \sigma_{\lambda}^2 & \text{if } t = s, \\ 0 & \text{if } t \neq s \end{cases},$$  \hspace{1cm} (84)

$$Eu_i\sigma_{js} = \begin{cases} \sigma_u^2 & \text{if } i = j, \ t = s, \\ 0 & \text{if } \text{otherwise} \end{cases},$$  \hspace{1cm} (85)

and

$$Ea_iX_i = E\lambda_iX_i = Eu_iX_i = 0.$$  \hspace{1cm} (86)

Given these assumptions, the variance of $Y_i$ conditional on $X_i$ is

$$\sigma_y^2 = \sigma_a^2 + \sigma_{\lambda}^2 + \sigma_u^2.$$  \hspace{1cm} (87)

The variances $\sigma_a^2$, $\sigma_{\lambda}^2$ and $\sigma_u^2$ are known as variance components. This kind of model thus is sometimes called a variance component or error component model, and for ease of exposition we assume $\lambda_t = 0$ for all $t$ (Hsiao, 2003: 34). In using the
composite error term, we then can rewrite equation (71) as

\[ y_{it} = x_{it}^T \beta + v_{it}, \quad \left( v_{it} = \nu_{i1}, \nu_{i2}, \ldots, \nu_{iT} \right). \quad (88) \]

Using the above assumptions, we have:

\[ E(v_{it}^2) = E(a_i^2) + 2E(a_iu_a) + E(u_a^2), \]
\[ = \sigma_a^2 + \sigma_u^2, \quad (89) \]

and

\[ E(v_{ia}v_{ia}) = E[(a_i + u_a)(a_i + u_a)], \]
\[ = E(a_i^2) = \sigma_a^2. \quad (90) \]

The variance-covariance matrix of \( v_{ia} \) is

\[ \Omega = E(v_{i1}v_{i1}^T) = \begin{bmatrix}
\sigma_a^2 + \sigma_u^2 & \sigma_a^2 & \cdots & \sigma_a^2 \\
\sigma_a^2 & \sigma_a^2 + \sigma_u^2 & \cdots & \sigma_a^2 \\
\vdots & \ddots & \ddots & \vdots \\
\sigma_a^2 & \cdots & \sigma_a^2 + \sigma_u^2
\end{bmatrix} = \sigma_a^2 I_T + \sigma_u^2 j_{T} \tilde{j}_{T}, \quad (91) \]

where \( j_{T} \tilde{j}_{T} \) is the \( T \times T \) matrix with unity in every element (Wooldridge, 2002: 258 – 259).

It should be noted that since \( a_i \) is in the composite error in each time period. The PO estimator is inefficient since \( v_a \) are serially correlated across time due to

\[ \text{If } \lambda_t \neq 0, \text{ equation (80) was known as the two-way error component model (Baltagi, 1995: 27).} \]
\[ \text{Corr} \left( v_{it}, v_{is} \right) = \frac{\sigma_{a_{i}}^{2}}{\sigma_{a_{i}}^{2} + \sigma_{u}^{2}}, \quad t \neq s. \] (92)

Therefore, to implement the PO estimator, we have to robust to this problem. Conversely, if we are concerned with efficiency, we may consider the Generalized Least Squared (GLS) estimator, which takes this serial correlation into account. The RE estimator is the GLS estimator, which takes this problem into account.  

Deriving the GLS transformation, which eliminates the serial Correlation in the error, is quite complicated. (see the details in Wooldridge, 2002: 286). However, we can show that the final transformation process can produce an efficient estimator (the RE estimator) by defining:

\[ \theta = 1 - \left[ \frac{\sigma_{u}^{2}}{\sigma_{u}^{2} + T \sigma_{a_{i}}^{2}} \right]^{\frac{1}{2}}, \] (93)

where \( \theta \) is one of the components in \( \Omega \) which is an usual weights in the GLS estimator (Wooldridge, 2002: 286). Then, assume we know \( \theta \) and use it to yield the transform equation as

\[ \bar{y}_{it} - \bar{\theta} \bar{v}_{i} = \left( X_{it} - \bar{X}_{i} \right) \beta + \left( \bar{v}_{it} - \bar{\theta} \bar{v}_{i} \right), \] (94)

where the overbar denote the time average.  

It should be noted that the errors in this equation are now serially uncorrelated and so it is an efficient estimator.  

62 The FE and FD models can also be estimated by a feasible GLS. If in fact \( u_{it} \) are \( \text{iid} \left[ 0, \sigma_{u}^{2} \right] \) then there are no gains in doing a GLS (Cameron and Trivedi, 2005: 725-731).  

63 It should be noted that each variable for equation (94) is a quasi-demeaned data because they are subtracted by a fraction of a time average, which depends on \( \sigma_{a_{i}}^{2}, \sigma_{u}^{2} \) and the number of time periods, rather than subtracted by the time average from the corresponding variable as in the FE estimator.  

64 There is a relationship between the RE, PO and FE model through equation (94) in that if \( \theta = 1 \) equation (94) is FE model, while the PO is obtained when \( \theta = 0 \). Nevertheless, in practice, \( \theta \) is never zero or one, but if \( \hat{\theta} \to 1 \), the RE will be close to the FE, while if \( \hat{\theta} \to 0 \), the RE and PO estimates are very similar.
Nevertheless, the parameter \( \theta \) is not known and thus it has to be estimated first. To obtain \( \hat{\theta} \), this involves estimating \( \sigma_{a_i}^2 \) and \( \sigma_u^2 \). The \( \sigma_{a_i}^2 \) and \( \sigma_u^2 \) can be based on the pooled OLS or fixed effects residuals, for example, a consistent estimators of \( \sigma_{a_i}^2 \) and \( \sigma_u^2 \) that are based on the pooled OLS are

\[
\hat{\sigma}_{a_i}^2 = \frac{1}{NT(T - 1)/2-K} \sum_{n=1}^{N} \sum_{t=1}^{T} \hat{\nu}_{it} \hat{\nu}_{it},
\]

(95)

\[
\hat{\sigma}_u^2 = \frac{1}{[NT-K]} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{\nu}_{it},
\]

(96)

\[
\dot{\sigma}_u^2 = \hat{\sigma}_u^2 - \dot{\sigma}_{a_i}^2,
\]

(97)

where the \( \hat{\nu}_{it} \) are the residual from estimating equation (88) by pooling the OLS (Wooldridge, 2002: 260 – 261). We then plug \( \hat{\sigma}_{a_i}^2 \) and \( \dot{\sigma}_u^2 \) into equation (93) to obtain \( \hat{\theta} \). The feasible GLS estimator that use \( \hat{\theta} \) in place of \( \theta \) is known as the RE estimator (Wooldridge, 2002: 260) which may be written as

\[
\dot{\beta}_{RE} = \left( \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{\nu}_{it} \hat{\Omega}^{-1} \hat{x}_{it} \right)^{-1} \left( \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{x}_{it} \hat{\Omega}^{-1} \hat{y}_{it} \right),
\]

(98)

where

\[
\hat{\Omega} = E(v_i\hat{v}_i') = \hat{\sigma}_u^2 I_T + \dot{\sigma}_a^2 \hat{J}_T \hat{J}_T',
\]

(99)

is the variance-covariance matrix of \( v_{it} \) and \( E(u_{it}^2) = \sigma_u^2, E(a_i^2) = \sigma_a^2 \), while \( \dot{\sigma}_u^2, \dot{\sigma}_a^2 \) is a consistent estimator of \( \sigma_u^2 \) and \( \sigma_a^2 \).

---

\(^{65}\) For estimating \( \sigma_u^2 \) and \( \sigma_a^2 \) see Wooldridge (2002: 260-261).
3.3 Panel Data Model Selection and Robustness

So far we have four estimators of the panel data model: the FE, FD, PO and RE estimators. Clearly, these four estimators are divided into two main groups of estimator; that is, fixed effects and random effects models. Fixed effects models assume $E(X_i,a_i) \neq 0$, while random effects models assume $E(X_i,a_i) = 0$. Therefore selecting between these two models depends on whether $a_i$ and $X_i$ are correlated. Hausman (1978: 1251 – 1271) first proposed a test which tested the hypothesis that $a_i$ is uncorrelated with $X_i$. The null hypothesis is that the $a_i$ is distributed independently of the $X_i$. If this is correct, both models are consistent, but the fixed effects will be inefficient. Conversely, if the null hypothesis is false, the random effect will be to unobserved heterogeneity bias.

The Hausman statistic can be computed as

$$H = (\hat{\beta}_{FE} - \hat{\beta}_{RE}) \left[ \text{var}(\hat{\beta}_{FE}) - \text{var}(\hat{\beta}_{RE}) \right]^{-1} (\hat{\beta}_{FE} - \hat{\beta}_{RE}).$$

(100)

Using matrix notation, under the null hypothesis, this test statistic has a chi-squared distribution ($\chi^2$). If we cannot reject the null hypothesis, we may decide to use the RE model on the grounds that this model is efficient.

Next, suppose that the Hausman test indicates that we should use the RE model. We may then test for the presence of an underserved effect because the model may not actually contain an unobserved effect. The absence of an unobserved effect is statistically equivalent to $H_0 : \sigma^2_{\epsilon_i} = 0$. Several tests have been developed to test this

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66 In case that we are interested in only a single parameter, we can use t-test version of the Hausman test as

$$t^H = \frac{\hat{\beta}_{FE} - \hat{\beta}_{RE}}{\text{se}(\hat{\beta}_{FE}) - \text{se}(\hat{\beta}_{RE})}$$

where se denote the standard errors which are computed under the usual assumptions and the $t^H$ statistic has an asymptotic standard normal distribution (Wooldridge, 2002: 290).
hypothesis, but the most common is the Lagrange Multiplier test of Breusch and Pegan (1980: 239-253). The test statistic is based on the PO residuals and for a balanced panel is written as

$$LM = \frac{NT}{2(T-1)} \left[ \sum_{i} \left( \sum_{t} \hat{v}_{it} \right)^2 \sum_{i} \sum_{t} \hat{v}_{it}^2 - 1 \right],$$ (101)

where $\hat{v}_{it}$ is the estimated PO residual. The test statistic has a chi-squared distribution with one degree of freedom under the null hypothesis of no random effects. Nevertheless, for a short panel ($N \to \infty$, but $T$ is a few period) a formal test for the presence of unobserved effects is not possible due to the incidental parameters problem. Instead, the Hausman test is used to test the null hypothesis of random effect against the alternative of fixed effects (Cameron and Trivedi, 2005: 737).

Finally, after we get an appropriate estimator for each model, we have to be certain that the estimator is efficient. To obtain an efficient estimator we usually assume that the idiosyncratic errors $u_{it}$ have a constant unconditional variance across $t$:

$$E(u_{it}^2) = \sigma^2_u,$$ (102)

and are serially uncorrelated

$$E(u_{it}u_{is}) = 0, \quad \text{all } t \neq s,$$ (103)

or are equivalent to the variances matrix as

$$E(u_{it}u_{it}'|X_i, a_i) = \sigma^2_u I_T.$$ (104)

In the case of the FD estimator, the variance matrix is

$$E(e_i e_i'|X_{it}, a_i) = \sigma^2_e I_T, \quad e_{it} = \Delta u_{it}.$$
If these two assumptions are violated, we have to robust the variance matrix estimator. However, rather than compute a robust variance matrix for the FE and the FD estimators, we may use the FEGLS and the FDGLS respectively. Robust a variance matrix estimator is also implemented in the random effects model because \( E(v_i, v_i) \) may not have a random effects structure due to serial correlation and heteroscedasticity problem in \( u_{it} \). Therefore, to ensure that the PO and the RE estimators are efficient, it is always a good idea to make the analysis robust whenever feasible. With fixed T and large N asymptotics, we lose nothing in using the robust standard errors and test statistics even if assumption \( E(u_iu_i'x_i, x_i) = \sigma_u^2 I_T \) and \( E(u_i^2|x_i) = \sigma_{a_i}^2 \) hold (Wooldridge, 2002: 263). Using heteroskedasticity robust standard errors and cluster-robust standard errors, nonetheless, is incompatible with the Hausman test, and choosing between the FE and the RE estimators has to use the General Method of Moment (GMM) approach by using the Sargento-Hansen statistic, which is a generalization of the Hausman test (see Schafer and Stillman, 2006).

### 3.4 Data Description

There are two sources of data used for this study. First, the Thai Household Socio Economic Panel Survey collected by the National Statistical Office (NSO) provides socioeconomic data on Thai households as with the Thai Socio-Economic Surveys (SES) but has fewer details. Second, the Meteorological department in the Ministry of Information and Technology provides regional rainfall data during 1998 – 2007 from 115 weather stations in Thailand. Only 83 weather stations however were utilized due to a matching up process; that is, households were matched to only the nearest weather stations.

The Thai Household Socio Economic Panel Survey is the first panel dataset conducted by an organization of the Thai government. Under this survey, the households were interviewed repeatedly in every year from 2005 to 2007. In each survey round, sample households from 76 provinces all over the country both inside

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68 See the details in Wooldridge (2002: 276-283).
and outside municipal areas, were selected using two-stage stratified sampling. Approximately 6,000 households were chosen in the first round, but then these households contributed response rate was about 96.2 and 93.1 percent in 2006 and 2007 respectively. However, because this study involves the study of the impact of transitory income shocks and income variance as a result of rainfall variability on household consumption, only crop farmers were chosen.\textsuperscript{69} Therefore, approximately 5,650 households from all rounds are used to be the total observations in this study.

Table 3.1 presents the summary statistics used in all empirical analyses in this study. Annual total income and expenditure consumption were derived from asking households in the year before the survey. Total income is the summation of farm profit and nonfarm income in terms of wage, salary and benefits while total expenditures include expenditures on all goods and services. Savings is the difference between total income and total expenditures.\textsuperscript{70} Borrowings are derived by asking households about their borrowings from all borrowing sources in the year before the survey. Transfer receipts from nonmember households, which were a proxy of risk sharing instrument were money and value of gift that household receive from other households. All money variables are adjusted using the Provincial Consumer Price Index (PCPI) provided by the Internal Commercial Department in the Ministry of Commercial in each year of the panel data to obtain real values from the nominal figures derived from the survey rounds. Owned land and unowned land are the main determinants of the permanent income of farm households. Most households generally have their owned land. However, a large number of households nevertheless do not have their owned land and thus they use unowned land in terms of rented land, public land, and conserved forest and others to cultivate their crops. Additionally, many households use both owned land and unowned land for their cultivation.

Due to a concern about the different soil quality in each region this paper controls soil quality by including the soil type variable into the model. These soil quality data have been studied by Nuansri Kanchanakul; Suwannee Phuthavatrat and

\textsuperscript{69} Since Thai Household Socio Economic Panel Survey report occupation’s detail less than SES, sample households in this study thus are different from Paxson’s study (Paxson, 1992: 15-33) which used rice farmers as a sample household. This is thus another key difference with Paxson’s study.

\textsuperscript{70} Savings defined in this paper is a traditional measure of savings and corresponds closely to the concept of savings used in the national accounts (Paxson, 1992: 20).
<table>
<thead>
<tr>
<th>Variable</th>
<th>Variables description</th>
<th>Means</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income</td>
<td>Farm profit plus nonfarm profit</td>
<td>133383.80</td>
<td>168439.60</td>
</tr>
<tr>
<td>Consumption</td>
<td>Total expenditures</td>
<td>94651.40</td>
<td>81884.530</td>
</tr>
<tr>
<td>Savings</td>
<td>Income minus total expenditures</td>
<td>38732.440</td>
<td>81884.530</td>
</tr>
<tr>
<td>Borrowings</td>
<td>Borrowings of household members</td>
<td>44721.200</td>
<td>139727.600</td>
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<td>Nonmember_transfer</td>
<td>Transfer receipts from nonmember household</td>
<td>15848.870</td>
<td>52011.080</td>
</tr>
<tr>
<td>Owned_land</td>
<td>Land of household which is not rented land, public land or conserved forest</td>
<td>16.260</td>
<td>48.437</td>
</tr>
<tr>
<td>Unowned_land</td>
<td>Rented land and public land including conserved forest</td>
<td>4.538</td>
<td>42.287</td>
</tr>
<tr>
<td>Soil_fertility</td>
<td>Dummy variable for soil quality (equal to 1 if household locate in Central, Eastern, Western or Northern regions which have a good quality of soil)</td>
<td>0.369</td>
<td>0.482</td>
</tr>
<tr>
<td>Head_illness</td>
<td>Illness of household head</td>
<td>0.0185</td>
<td>0.135</td>
</tr>
<tr>
<td>Head_age</td>
<td>Age of household head</td>
<td>52.273</td>
<td>13.049</td>
</tr>
<tr>
<td>Head_age_squared</td>
<td>Squares of age of household head</td>
<td>2902.773</td>
<td>1430.110</td>
</tr>
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<td>Members 0_5</td>
<td>Number of household members age under 6</td>
<td>0.316</td>
<td>0.548</td>
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<td>Number of household male members age between 6 to 11</td>
<td>0.235</td>
<td>0.479</td>
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<tr>
<td>Females 6_11</td>
<td>Number of household female members age between 6 to 11</td>
<td>0.209</td>
<td>0.453</td>
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<tr>
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<td>Number of household female members age between 12 to 17</td>
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<tr>
<td>Males_primary</td>
<td>Number of household male members age between 18 to 64 and have a primary level of education</td>
<td>0.804</td>
<td>0.628</td>
</tr>
<tr>
<td>Females_primary</td>
<td>Number of household female members age between 18 to 64 and have a primary level of education</td>
<td>0.913</td>
<td>0.567</td>
</tr>
<tr>
<td>Males_secondary</td>
<td>Number of household male members age between 18 to 64 and have a secondary level of education</td>
<td>0.296</td>
<td>0.524</td>
</tr>
</tbody>
</table>
Table 3.1 (Continued)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Variables description</th>
<th>Means</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Females_secondary</td>
<td>Number of household female members age between 18 to 64 and have a secondary level of education</td>
<td>0.219</td>
<td>0.446</td>
</tr>
<tr>
<td>Males_postsecondary</td>
<td>Number of household male members age between 18 to 64 and have a postsecondary level of education</td>
<td>0.087</td>
<td>0.300</td>
</tr>
<tr>
<td>Females_postsecondary</td>
<td>Number of household female members age between 18 to 64 and have a postsecondary level of education</td>
<td>0.141</td>
<td>0.374</td>
</tr>
<tr>
<td>Members_65up</td>
<td>Number of household members age over 64</td>
<td>0.335</td>
<td>0.619</td>
</tr>
<tr>
<td>Dev_rain</td>
<td>The deviation of rainfall</td>
<td>45.880</td>
<td>226.935</td>
</tr>
<tr>
<td>Squared_dev_rain</td>
<td>Squared of the deviation of rainfall</td>
<td>53955.370</td>
<td>109065.100</td>
</tr>
<tr>
<td>Ownedland_xi_dev</td>
<td>The interaction term between owned land and the deviation of rainfall</td>
<td>650.870</td>
<td>10789.180</td>
</tr>
<tr>
<td>Unownedland_xi_dev</td>
<td>The interaction term between unowned land and the deviation of rainfall</td>
<td>246.197</td>
<td>3913.211</td>
</tr>
<tr>
<td>Soil_fertility_xi_dev</td>
<td>The interaction term between soil fertility and the deviation of rainfall</td>
<td>32.817</td>
<td>144.172</td>
</tr>
<tr>
<td>Head_age_xi_dev</td>
<td>household head and the deviation of rainfall</td>
<td>2460.970</td>
<td>12267.170</td>
</tr>
<tr>
<td>Members0_5</td>
<td>Number of household members age under 6</td>
<td>0.316</td>
<td>0.548</td>
</tr>
<tr>
<td>Members6_11</td>
<td>Number of household members age 6 to 11</td>
<td>0.444</td>
<td>0.654</td>
</tr>
<tr>
<td>Members12_17</td>
<td>Number of household members age 12 to 17</td>
<td>0.429</td>
<td>0.627</td>
</tr>
<tr>
<td>Members18_60</td>
<td>Number of household members age 18 to 60</td>
<td>2.323</td>
<td>1.109</td>
</tr>
<tr>
<td>Members61_up</td>
<td>Number of household members age over 60</td>
<td>0.466</td>
<td>0.709</td>
</tr>
</tbody>
</table>

**Notes:**

1.) Data used in this study is yearly data
2.) Unit of all money variables is baht and unit of land variable is rai (1 rai: 1,600 square meters)

Kanitsri Hultrakul. (2000:5-13). In their study, they concluded that the northeastern and southern regions of Thailand have low-quality soil, while other regions have high-quality soil. The illness and experience of household heads were other factors which determined household income, especially farm households. They thus are also
included in the present study. Age of household head was used as a proxy variable for household head’s experience.\textsuperscript{71} The number of household numbers, which was classified by gender, age, and education levels, was the final set of household demographic variables included in the model of this paper. This study still follows Paxson’s classification, because it has been a good classification for controlling farm household demographics.

The deviation of rainfall from its long-term average and its squared are included in the model by conjunction with the panel data on household income in order to construct the estimates of transitory income due to rainfall shocks. These rainfall variables were constructed by annual regional rainfall data obtained by summing the monthly regional rainfall data that were reported by each regional weather station. The annual regional rainfall data from 83 weather stations are presented in Appendix A. The weather stations which were selected for this paper are located all over the country, in all regions and provinces. It nonetheless should be noted that many weather stations are not located in Muang district and instead it are located in other districts. This might be a good diffusion for matching up with the scattering of sample households.

Figure 3.1 and 3.2 show the means and standard deviation of annual rainfall in each region. These figures show that the means and standard deviation of annual rainfall of all regions are quite similar, except for the southern region, which locates in a different geographic areas from other regions in Thailand. Therefore the rainfall in the south has clearly a large deviation from other regions.

Apart from rainfall data, the decomposed income data were other data that should were clarified for this section. These decomposed income variables (i.e transitory income, permanent income and unexplained income) were actually generated after the income equation was estimated. An appropriate classification in the presentation of these variables will be described in this section. Table 3.2 shows means of decomposed income variables which was decomposed after the income variables for total observations were estimated. According to the identity of the

\textsuperscript{71} The squared of household head’s age is also included in order to obtain a nonlinear relationship between age of household head and household income (Lausurdi, 1997: 323)
Figure 3.1 Yearly average rainfall

Figure 3.2 Yearly standard deviation rainfall
Table 3.2 Decomposed Income Variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>Observations</th>
<th>Means</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total income</td>
<td>5650</td>
<td>133383.8</td>
<td>168439.6</td>
</tr>
<tr>
<td>Transitory income</td>
<td>5648</td>
<td>-13406.26</td>
<td>82593.68</td>
</tr>
<tr>
<td>Permanent income</td>
<td>5648</td>
<td>154924.7</td>
<td>33424.2</td>
</tr>
<tr>
<td>Unexplained income</td>
<td>5648</td>
<td>-8130.972</td>
<td>180560.9</td>
</tr>
</tbody>
</table>

Note: Calculated from table 4.1 for group of all region

Table 3.3 Negative and Positive Transitory Income

<table>
<thead>
<tr>
<th>Variables</th>
<th>Observations (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative transitory income</td>
<td>63.7</td>
</tr>
<tr>
<td>Positive transitory income</td>
<td>36.3</td>
</tr>
</tbody>
</table>

Note: Calculated from table 4.1 for group of all region

Table 3.4 The Proportion of Negative Income Shocks per Total income

<table>
<thead>
<tr>
<th>Variables</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>more than 10 %</td>
<td>43.7</td>
</tr>
<tr>
<td>more than 20 %</td>
<td>37.2</td>
</tr>
<tr>
<td>more than 30 %</td>
<td>33.3</td>
</tr>
<tr>
<td>more than 40 %</td>
<td>29.5</td>
</tr>
<tr>
<td>more than 50 %</td>
<td>26.3</td>
</tr>
</tbody>
</table>

Note: Calculated from table 4.1 for group of all region case

income variable in the PIH, we should note that the summation of these decomposed income variables is always equal to total income. Additionally, we should note that transitory income accounts for around 10% of total income in Thai agricultural households, which may be not a high proportion. However, when we separate this
transitory income variable as shown in table 3.3 we find that 63.7% of transitory income shocks that are faced by Thai agricultural households are negative shocks, while 36.3% are positive shocks.

Furthermore, when we examine further this variable, as shown in table 3.4, we find that around 43.7% of Thai agricultural households in this study have a proportion of negative income shock per total income over 10%, and the more this proportion increases, the fewer number of households have. Nevertheless, it should be noted that around 26.3% of households have a proportion of negative income shock per total income over 50%. These data indicate that even if the proportion of transitory income per total income for Thai agricultural households is not too high, the transitory income shock faced by households of more than 50% is a negative income shock. Moreover, more than 40% of households have a proportion of negative income shock per total income of more than 10%. Additionally, according to the PIH, if the Thai credit markets are not complete and households have no consumption smoothing mechanisms, a large number of Thai agricultural households may face hardship.
CHAPTER 4

EMPIRICAL ANALYSIS

To investigate whether Thai agricultural households behave following the hypothesis, which explained in the second chapter, we have to test following our specifications’ procedure, as presented in the previous chapter. The first stage is the measurement of permanent and transitory income by modifying Fafchamps, Udry and Czukas’s (1996: 273-305) and Jacoby and Skoufias’s (1997: 311-335) approach. In addition, by using some estimate parameters from this step, we also construct income variance by applying Kazianga and Udry’s (2006: 434) approach.

4.1 Empirical Results

4.1.1 Income equation estimation

Table 4.1 reports the estimates of the reduced-form income equations from equation (63). The table shows separately the results among the three groups of regions. These regions are separately examined since the rainfall quantity in some of regions is different and furthermore the rainfall data is also a key variable for our study. Additionally, there is also the difference in the main crops cultivated in some regions, which may respond differently to rainfall. We thus investigate the first group by summing all of the regions in order to obtain an overview of the results. We then exclude Southern region due to a high difference in both the means and standard deviation and the main crop cultivation in this region. Finally, we group households in the Northern and Northeastern regions to be the third group as a result of the similarity of rainfall data in those areas and the several types of cultivated crops. All of these groups are tested using fixed effect regression due to a significance at the 1%

72 Rice is the main crop which is cultivated by households in the Northern and Northeastern regions while households in the Southern region cultivate mostly in rubber.
Table 4.1 Fixed Effect Income Regressions (group of regions)

Dependent variable: Income

<table>
<thead>
<tr>
<th>Regions</th>
<th>All regions</th>
<th>All regions except Southern region</th>
<th>Northern and Northeastern regions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variables</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Owned_land</td>
<td>204.656</td>
<td>179.957</td>
<td>128.301</td>
</tr>
<tr>
<td>Unowned_land</td>
<td>-20.984</td>
<td>24.559</td>
<td>52.611</td>
</tr>
<tr>
<td>Dev_rain</td>
<td>485.024</td>
<td>244.215</td>
<td>225.902</td>
</tr>
<tr>
<td>Squared_dev_rain</td>
<td>-0.345</td>
<td>-0.242</td>
<td>0.199</td>
</tr>
<tr>
<td>Owned_land_xi_dev</td>
<td>-1.007</td>
<td>-0.880</td>
<td>-0.647</td>
</tr>
<tr>
<td>Unowned_land_xi_dev</td>
<td>-0.191</td>
<td>-0.944</td>
<td>-1.430</td>
</tr>
<tr>
<td>Soil_fertility_xi_dev</td>
<td>-458.516</td>
<td>-233.727</td>
<td>-342.398</td>
</tr>
<tr>
<td>Head_age_xi_dev</td>
<td>-0.576</td>
<td>-0.003</td>
<td>-0.611</td>
</tr>
<tr>
<td>Head_illness</td>
<td>-3032.222</td>
<td>-397.659</td>
<td>2408.810</td>
</tr>
<tr>
<td>Head_age</td>
<td>2146.525</td>
<td>1609.203</td>
<td>1194.379</td>
</tr>
<tr>
<td>Head_age_squared</td>
<td>-15.862</td>
<td>-9.316</td>
<td>-5.609</td>
</tr>
<tr>
<td>Members_0_5</td>
<td>-1229.261</td>
<td>108.052</td>
<td>-1491.168</td>
</tr>
<tr>
<td>Males_6_11</td>
<td>8592.299</td>
<td>5584.291</td>
<td>555.494</td>
</tr>
<tr>
<td>Females_6_11</td>
<td>4952.401</td>
<td>8032.726</td>
<td>7605.573</td>
</tr>
<tr>
<td>Males_12_17</td>
<td>6297.205</td>
<td>113.564</td>
<td>-1033.812</td>
</tr>
<tr>
<td>Females_12_17</td>
<td>18821.470</td>
<td>21911.100</td>
<td>24301.430</td>
</tr>
<tr>
<td>Males_primary</td>
<td>29477.570</td>
<td>23836.130</td>
<td>17645.700</td>
</tr>
<tr>
<td>Females_primary</td>
<td>21460.070</td>
<td>32503.800</td>
<td>36995.750</td>
</tr>
<tr>
<td>Males_secondary</td>
<td>35060.240</td>
<td>32854.050</td>
<td>25828.680</td>
</tr>
<tr>
<td>Females_secondary</td>
<td>22033.040</td>
<td>16712.830</td>
<td>16501.990</td>
</tr>
<tr>
<td>Males_postsecondary</td>
<td>20707.060</td>
<td>13100.480</td>
<td>20124.910</td>
</tr>
<tr>
<td>Females_postsecondary</td>
<td>15802.820</td>
<td>20133.430</td>
<td>11314.210</td>
</tr>
<tr>
<td>Members_65up</td>
<td>12996.530</td>
<td>11761.370</td>
<td>5609.110</td>
</tr>
<tr>
<td>Cons</td>
<td>(159.392)***</td>
<td>(71.111)***</td>
<td>(73.760)***</td>
</tr>
</tbody>
</table>

Notes: *** p < 0.001, ** p < 0.01, * p < 0.05
Table 4.1 (Continued)

Dependent variable: Income

<table>
<thead>
<tr>
<th>Regions</th>
<th>All regions</th>
<th>All regions except Southern region</th>
<th>Northern and Northeastern regions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of observations</td>
<td>5648</td>
<td>4903</td>
<td>4144</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.053</td>
<td>0.090</td>
<td>0.085</td>
</tr>
<tr>
<td>Sargent-Hansen test</td>
<td>2.9e+07***</td>
<td>9.9e+06***</td>
<td>1.0e+06***</td>
</tr>
<tr>
<td>F-tests</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test 1</td>
<td>3.860***</td>
<td>4.460***</td>
<td>6.510***</td>
</tr>
<tr>
<td>Test 2</td>
<td>3.600***</td>
<td>3.890***</td>
<td>3.100</td>
</tr>
<tr>
<td>Test 3</td>
<td>5.460***</td>
<td>11.530***</td>
<td>6.340***</td>
</tr>
<tr>
<td>Test 4</td>
<td>10602.580***</td>
<td>1394.840***</td>
<td>46835.290***</td>
</tr>
</tbody>
</table>

Notes: 1.) Robust standard errors in brackets under coefficients
2.) * significant at 10%; ** significant at 5%; ***significant at 1%

level for the Sargent-Hansen test in every group.

When looking at the impact of explanatory variables on household income, we find that owned land has a large positive significant effect on household income at the 1% level, while unowned land is not significant in for any of the region groups; the land ownership variables are nevertheless jointly significant at the 1% level for the F-statistic test in all of the region groups. This might be a general characteristic of most agricultural households, in which land is one of the main factors that determine income. For a set of the individual rainfall variables, we find that most individual rainfall variables are highly significant. Rainfall deviation has a positive significant impact on household income in all of the region groups, while its square has a negative significant relationship in most of the region groups. These results are still consistent with Paxson’s previous study in Thailand (Paxson, 1992: 15-33).

Furthermore, it is find that most of the interaction terms between rainfall deviation with household characteristics, that is, owned land, unowned land, soil fertility, and household experience, show a negative significant relationship with household income. This means that rainfall may not only affect income directly but also through household characteristic. More specifically, the income of household
with household characteristics exhibits a negative sensitivity in relation to rainfall variations. The negative, significant impact of this relation has been supported by many previous studies which used the same technique, for example, Fafchamps, Udry and Czukas (1998, 273-306) and Kazianga and Udry (2006: 413-446). As a result of the significance of most rainfall variables, the null hypothesis that these rainfall variables are jointly insignificant is rejected at the 1% level across all of the region groups (the F-statistic ranges from 5.46-11.53). This should support our claim that regional rainfall variation may explain transitory income and income variance.

As with the study of Paxson (Paxson, 1992: 15-33), we still find that most household characteristic variables, especially household members whose age is over 17, have a positive significant impact on household income in all of the region groups. On the other hand, we find no the relationship between household income and household members whose age is under 12. In addition we find no impact of household head’s illness, which is the only proxy of the idiosyncratic shock in this study, on household income; however, in all region groups, aggregate shocks, as proxied by village (tambon)-year dummy variables, were statistically jointly significant at the 1% level (the F-statistic range from 1394.84-46835.29).

To further specify whether there is a different determinant of household income for each region. Fixed effect income regression is tested by separating results, as shown in table 4.2. Unlike testing of region groups, the impact of explanatory variables on household income is different for each region. Even though unowned land is still insignificant, as with all region groups, owned land is significant in the Northeastern and the group of Central, Eastern and Western regions. We find a little evidence of the relationship between the set of rainfall variables and household income for each region\textsuperscript{73}; for example, only rainfall deviation square and the interaction between owned land and rainfall deviation are significant in the Northeastern region, while only rainfall deviation square is significant in the group of Central, Eastern and Western regions. Consequently, the null hypothesis that these rainfall variables are jointly insignificant is rejected at the 1 % level only in the

\textsuperscript{73}Many studies which have applied this approach also found little evidence of the impact of the individual rainfall variables on farm household income, such as those of Fafchamps, Udry and Czukas (1998: 273-306) and Kazainga and Udry (2006: 413-446).
### Table 4.2 Fixed Effect Income Regressions (each region)

**Dependent variable:** Income

<table>
<thead>
<tr>
<th>Regions:</th>
<th>Northern</th>
<th>Southern</th>
<th>Northeastern</th>
<th>Central, Eastern and Western</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Owned_land</td>
<td>418.871</td>
<td>585.647</td>
<td>101.010</td>
<td>2390.422</td>
</tr>
<tr>
<td></td>
<td>(543.859)</td>
<td>(676.505)</td>
<td>(33.367)***</td>
<td>(835.398)***</td>
</tr>
<tr>
<td>Unowned_land</td>
<td>-787.761</td>
<td>-742.239</td>
<td>40.671</td>
<td>14.369</td>
</tr>
<tr>
<td></td>
<td>(677.432)</td>
<td>(2505.049)</td>
<td>(75.935)</td>
<td>(1048.843)</td>
</tr>
<tr>
<td>Dev_rain</td>
<td>-100.016</td>
<td>-1200.979</td>
<td>132.967</td>
<td>-127.245</td>
</tr>
<tr>
<td></td>
<td>(130.162)</td>
<td>(106.4290)</td>
<td>(86.838)</td>
<td>(133.151)</td>
</tr>
<tr>
<td>Squared_dev_rain</td>
<td>0.073</td>
<td>-1.720</td>
<td>0.722</td>
<td>-0.438</td>
</tr>
<tr>
<td></td>
<td>(0.160)</td>
<td>(1.805)</td>
<td>(0.214)***</td>
<td>(0.171)***</td>
</tr>
<tr>
<td>Ownedland_xi_dev</td>
<td>-1.104</td>
<td>-1.166</td>
<td>-0.566</td>
<td>-2.738</td>
</tr>
<tr>
<td></td>
<td>(1.193)</td>
<td>(2.176)</td>
<td>(0.143)***</td>
<td>(1.904)</td>
</tr>
<tr>
<td>Unownedland_xi_dev</td>
<td>-1.742</td>
<td>0.056</td>
<td>-1.052</td>
<td>0.108</td>
</tr>
<tr>
<td></td>
<td>(0.954)**</td>
<td>(5.046)</td>
<td>(1.194)</td>
<td>(3.406)</td>
</tr>
<tr>
<td>Head_age_xi_dev</td>
<td>0.202</td>
<td>-2.267</td>
<td>-1.038</td>
<td>2.427</td>
</tr>
<tr>
<td></td>
<td>(1.486)</td>
<td>(1.331)**</td>
<td>(0.935)</td>
<td>(2.521)</td>
</tr>
<tr>
<td>Head_illness</td>
<td>31559.750</td>
<td>-45582.340</td>
<td>-7823.936</td>
<td>99467.580</td>
</tr>
<tr>
<td></td>
<td>(19840.770)</td>
<td>(69331.990)</td>
<td>(17017.200)</td>
<td>(63229.550)</td>
</tr>
<tr>
<td>Head_age</td>
<td>4979.232</td>
<td>2029.775</td>
<td>-598.287</td>
<td>9771.212</td>
</tr>
<tr>
<td></td>
<td>(4916.282)</td>
<td>(6537.749)</td>
<td>(2269.468)</td>
<td>(7565.040)</td>
</tr>
<tr>
<td>Head_age_squared</td>
<td>-74.813</td>
<td>-33.191</td>
<td>28.159</td>
<td>-76.876</td>
</tr>
<tr>
<td></td>
<td>(48.029)</td>
<td>(55.851)</td>
<td>(28.779)</td>
<td>(65.696)</td>
</tr>
<tr>
<td>Members_0_5</td>
<td>-3188.394</td>
<td>-25777.050</td>
<td>-1965.296</td>
<td>10846.950</td>
</tr>
<tr>
<td></td>
<td>(18413.780)</td>
<td>(26261.410)</td>
<td>(7004.365)</td>
<td>(35094.100)</td>
</tr>
<tr>
<td>Males_6_11</td>
<td>-7271.794</td>
<td>1609.688</td>
<td>-62.8024</td>
<td>36864.830</td>
</tr>
<tr>
<td></td>
<td>(28477.460)</td>
<td>(42486.580)</td>
<td>(10042.330)</td>
<td>(34291.960)</td>
</tr>
<tr>
<td>Females_6_11</td>
<td>21161.200</td>
<td>-16684.860</td>
<td>1123.384</td>
<td>34412.920</td>
</tr>
<tr>
<td></td>
<td>(37156.130)</td>
<td>(45496.280)</td>
<td>(8585.200)</td>
<td>(38622.610)</td>
</tr>
<tr>
<td>Males_12_17</td>
<td>6596.579</td>
<td>32969.180</td>
<td>-6100.986</td>
<td>-21152.590</td>
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<tr>
<td></td>
<td>(23233.540)</td>
<td>(57950.970)</td>
<td>(10397.240)</td>
<td>(41947.520)</td>
</tr>
<tr>
<td>Females_12_17</td>
<td>18332.300</td>
<td>8087.916</td>
<td>27588.660</td>
<td>58198.560</td>
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<td>(40015.380)</td>
<td>(44288.100)</td>
<td>(9931.016)</td>
<td>(41282.980)</td>
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<tr>
<td>Males_primary</td>
<td>19852.770</td>
<td>12163.950</td>
<td>26009.620</td>
<td>-13061.850</td>
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<tr>
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<td>(17884.480)</td>
<td>(34243.370)</td>
<td>(8614.228)</td>
<td>(28777.080)</td>
</tr>
<tr>
<td>Females_primary</td>
<td>-18059.910</td>
<td>509.292</td>
<td>30392.700</td>
<td>60277.280</td>
</tr>
<tr>
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<td>(32381.710)</td>
<td>(39110.330)</td>
<td>(9735.243)</td>
<td>(38840.040)</td>
</tr>
<tr>
<td>Males_secondary</td>
<td>44433.610</td>
<td>-12701.210</td>
<td>34732.760</td>
<td>-8641.868</td>
</tr>
<tr>
<td></td>
<td>(24421.030)**</td>
<td>(40037.140)</td>
<td>(11154.190)***</td>
<td>(30240.570)</td>
</tr>
<tr>
<td>Females_secondary</td>
<td>8933.417</td>
<td>45842.110</td>
<td>31309.940</td>
<td>113777.400</td>
</tr>
<tr>
<td></td>
<td>(24693.030)</td>
<td>(40123.920)</td>
<td>(13953.510)***</td>
<td>(36789.420)***</td>
</tr>
<tr>
<td>Males_postsecondary</td>
<td>19323.340</td>
<td>-45472.660</td>
<td>9351.815</td>
<td>82284.870</td>
</tr>
<tr>
<td></td>
<td>(23226.040)</td>
<td>(76828.370)</td>
<td>(21986.570)</td>
<td>(39804.860)***</td>
</tr>
<tr>
<td>Females_postsecondary</td>
<td>35538.370</td>
<td>51850.570</td>
<td>-82.293</td>
<td>-9782.560</td>
</tr>
<tr>
<td></td>
<td>(26997.830)</td>
<td>(30303.760)**</td>
<td>(12223.410)</td>
<td>(34808.150)</td>
</tr>
<tr>
<td>Members_65up</td>
<td>17197.450</td>
<td>3110.181</td>
<td>11745.250</td>
<td>27682.450</td>
</tr>
<tr>
<td></td>
<td>(17532.340)</td>
<td>(38027.000)</td>
<td>(13007.300)</td>
<td>(40066.350)</td>
</tr>
<tr>
<td>Cons</td>
<td>85769.950</td>
<td>438502.100</td>
<td>-40978.240</td>
<td>-21921.200</td>
</tr>
<tr>
<td></td>
<td>(134714.000)</td>
<td>(294323.300)</td>
<td>(74975.200)</td>
<td>(211614.500)</td>
</tr>
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</table>
Table 4.2 (Continued)

Dependent variable: Income

<table>
<thead>
<tr>
<th>Variables</th>
<th>Northern</th>
<th>Southern</th>
<th>Northeastern</th>
<th>Central, Eastern and Western</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of</td>
<td>1325</td>
<td>745</td>
<td>2819</td>
<td>759</td>
</tr>
<tr>
<td>observations</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-squared</td>
<td>0.053</td>
<td>0.001</td>
<td>0.126</td>
<td>0.310</td>
</tr>
<tr>
<td>Sargento-Hansen</td>
<td>2.0e+04***</td>
<td>3338.881***</td>
<td>1.4e+04***</td>
<td>2.3e+04***</td>
</tr>
<tr>
<td>F-tests</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test 1</td>
<td>1.470</td>
<td>0.430</td>
<td>4.690***</td>
<td>4.53***</td>
</tr>
<tr>
<td>Test 2</td>
<td>1.510</td>
<td>0.800</td>
<td>3.650***</td>
<td>2.090***</td>
</tr>
<tr>
<td>Test 3</td>
<td>1.250</td>
<td>1.230</td>
<td>8.410***</td>
<td>5.000***</td>
</tr>
<tr>
<td>Test 4</td>
<td>2.1e+07***</td>
<td>61410.870***</td>
<td>486.430***</td>
<td>230.560***</td>
</tr>
</tbody>
</table>

Notes: 1.) Robust standard errors in brackets under coefficients
2.) * significant at 10%; ** significant at 5%; *** significant at 1%

Northeastern and the group of Central, Eastern and Western regions.

Similarly, the relationship between household characteristic variables and household income is different for each region. Only in the Northeastern region is it still find that most of the variables in household members whose age is over 17 have a positive significance as with testing on region groups, while there is little evidence of the relationship between the set of household characteristic variables and household income for other regions. Nevertheless, it should be noted that the most significant household characteristic variables in every region yielded a reasonable outcome in that they always have a high positive impact on household income. Additionally, it should also be noted that household members whose age is between 18 and 64, with a secondary level of education or higher, have the highest impact on household income in both region groups and most regions. This implies that households which have educated members may help to increase income for those households more than households whose members have less or no education.

We still find no impact of illness of household head on household income in any region. However, village (tambon)-year dummy variables, which represent and aggregate shocks, are still statistically and jointly significant at the 1% level in every region (F-statistic range from 2.1e+07 to 61410.87)
4.1.2 Consumption equation estimation

After we estimate the income equations in the first stage, some estimated parameters will be used to generate four key variables; i.e. permanent, transitory, and unexplained income, as well as income variance. These variables are implemented in testing their impact on household consumption as the second stage estimation for this paper. The regression results are shown in table 4.3 and 4.4.

Table 4.3 reports fixed effect consumption regression because the Sargent-Hansen test reports a 1% level of significance for all of region groups. We find some evidences of a statistically significant relationship between household consumption and transitory, permanent, and unexplained income only in the group of all regions. For the group of all regions and the group of all regions except the Southern region, the estimated propensity to consume out of transitory income is quite consistent with the PIH, in which the coefficient of transitory income should be close to zero, and several studies also support this result. These include Jacoby and Skoufias (1998: 1-14); Pistaferri (2001: 465-476) and Meng (2003: 465-485). Consequently, finding the estimated propensity to consume out of transitory income more than zero may significantly imply that some Thai agricultural households are still unable to smooth their consumption in the face of income shock due to rainfall variation.

Contrary to the effect of transitory income, although we find a significant relationship between household consumption and permanent income in the group of all regions, the consumption propensity out of permanent income is not consistent with the PIH. The coefficient of permanent income is close to zero rather than close to one, as explained by the PIH. This implies that the Thai agricultural household’s consumption depends less on permanent income. This evidence nevertheless may not be surprising for an empirical study. Meng (2003: 465-485) found that the consumption propensity out of permanent income was about 0.5 for total consumption and about 0.13 for food consumption, while Carroll (1994: 111-147) and Zhou (2003: 192-212) found that the coefficients are always small and are sometimes negative and insignificant. Moreover, an updated study of Jakinee Ruangthamasak (2008) on Thai household consumption which used the Thai Household Socio-Economic Survey (SES) in 2006 showed also a closing zero in her estimated permanent income coefficient.
Table 4.3 Fixed Effect Consumption Regression (group of regions)

<table>
<thead>
<tr>
<th>Variables</th>
<th>All regions</th>
<th>All regions except Southern region</th>
<th>Northern and Northeastern regions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transitory income</td>
<td>0.302</td>
<td>0.185</td>
<td>0.052</td>
</tr>
<tr>
<td></td>
<td>(0.107)***</td>
<td>(0.081)***</td>
<td>(0.101)</td>
</tr>
<tr>
<td>Permanent income</td>
<td>0.209</td>
<td>0.101</td>
<td>-0.019</td>
</tr>
<tr>
<td></td>
<td>(0.097)***</td>
<td>(0.087)</td>
<td>(0.101)</td>
</tr>
<tr>
<td>Unexplained income</td>
<td>0.087</td>
<td>0.083</td>
<td>0.083</td>
</tr>
<tr>
<td></td>
<td>(0.016)***</td>
<td>(0.019)***</td>
<td>(0.022)***</td>
</tr>
<tr>
<td>Variance of income</td>
<td>-3.88e-13</td>
<td>-1.32e-12</td>
<td>-5.75e-13</td>
</tr>
<tr>
<td></td>
<td>(1.65e-13)***</td>
<td>(5.27e-13)***</td>
<td>(2.34e-13)***</td>
</tr>
<tr>
<td>Head_illness</td>
<td>2246.160</td>
<td>2358.814</td>
<td>4628.051</td>
</tr>
<tr>
<td></td>
<td>(6476.290)</td>
<td>(6504.451)</td>
<td>(6854.272)</td>
</tr>
<tr>
<td>Members 0_5</td>
<td>6068.467</td>
<td>5803.776</td>
<td>6949.286</td>
</tr>
<tr>
<td></td>
<td>(3727.770)</td>
<td>(3964.023)</td>
<td>(4257.505)</td>
</tr>
<tr>
<td>Members 6_11</td>
<td>9836.365</td>
<td>11674.780</td>
<td>12907.160</td>
</tr>
<tr>
<td></td>
<td>(3693.142)***</td>
<td>(3817.259)***</td>
<td>(4050.327)***</td>
</tr>
<tr>
<td>Members 12_17</td>
<td>15746.600</td>
<td>19759.990</td>
<td>21366.370</td>
</tr>
<tr>
<td></td>
<td>(3703.723)***</td>
<td>(3733.735)***</td>
<td>(4294.037)***</td>
</tr>
<tr>
<td>Members 18_60</td>
<td>19899.080</td>
<td>22746.770</td>
<td>25888.910</td>
</tr>
<tr>
<td></td>
<td>(3251.749)***</td>
<td>(3159.610)***</td>
<td>(3867.528)***</td>
</tr>
<tr>
<td>Members 61_up</td>
<td>10642.960</td>
<td>14640.300</td>
<td>16111.050</td>
</tr>
<tr>
<td></td>
<td>(5117.994)***</td>
<td>(5154.851)***</td>
<td>(5767.064)***</td>
</tr>
<tr>
<td>Cons</td>
<td>307.920</td>
<td>1265.015</td>
<td>839.409</td>
</tr>
<tr>
<td></td>
<td>(12179.730)</td>
<td>(11139.920)</td>
<td>(10652.050)</td>
</tr>
</tbody>
</table>

| Number of observations     | 5648        | 4903                               | 4144                             |
| R-squared                  | 0.207       | 0.227                              | 0.215                            |
| Sargent-Hansen test        | 1.5e+11***  | 5.0e+09***                         | 3.8e+10***                       |
| F-tests:                   |             |                                    |                                  |
| Test 1                     | 66.630***   | 107.220***                         | 101.580***                       |
| Test 2                     | 0.790       | 0.950                              | 0.470                            |
| Test 3                     | 3.2e+06***  | 33076.960***                       | 94346.500***                     |

Notes: 1.) Robust standard errors in brackets under coefficients  
2.) * significant at 10%; ** significant at 5%; ***significant at 1%  
3.) Test 1: coefficient of YP = 1, Test 2: coefficient YT = coefficient of YP and Test 3: village-years dummies jointly insignificant.

The behavior of Thai agricultural households appears to be consistent evidently with a buffer stock model with a negative statistical significance at the 1%
level in all of the region groups. Our results are consistent with several studies, such as those of Dardanomi (1991:153-160); Carroll (1944: 111-147); Chen, Meilke and Turvey (1999: 173-183); Meng (2003: 465-485), as well as those of Jakinee Ruangthammasak (2008). Appearing to be a precautionary saving behavior among Thai agricultural households indicates that households will consume less if they expect higher future income variability due to rainfall variation. More specifically, households will not fully smooth their transitory shocks, but may permit consumption to drop in the face of transitory shocks, in order to preserve their buffer stocks against the possibility of future shock (Kazianga and Udry, 2006: 433).

There is little evidence of following the LCH among Thai agricultural households. Even though household members whose age is 6 to 11 and 12 to 17 appear to have a large positive significant impact on household consumption in most of region groups, and this result is quite consistent with the LCH in which the more children there are (including elders), the higher is household consumption, there is also the result which highly contradict with the LCH due to the largest positive significant impact of household members whose age is 18 to 60. These households should consume less and save more as an LCH prediction. This evidence may nevertheless be explained by the consumption boom hypothesis in Thailand during the period of this study. Kobsak Pootrakul; Thammanoon Sodsrichai and Kaitipong Ariyapruycha (2005: 9) indicate that the economic environment during that period, for example, the shifting of the attention of commercial banks toward consumer finance, intense competition among commercial banks and nonbank players in various markets together with a low interest rate environment, may have been the main factor for arousing household consumption. It is thus very possible that these circumstances may have encouraged the consumption of household members whose age is 18 to 60 that have own earning.

Moreover, there are several empirical studies that have shown that the age profile of consumption is hump-shaped rather than bump-shaped, predicted by the life-cycle model. This model states that a smooth consumption profile is independent of the shape of the income profile. A large amount of the literature shows, it turns out, that consumption and income had a similar hump-shape, with peaks of both paths occurring around age 50 (Hansen and Imrohoroglu, 2008: 566). These include the
work of Thurow (1969: 324-330), Carroll and Summers (1991: 305-348), Attanasio, Banks, Megir and Weber (1999: 22-35) and Gourinchas and Parker (2002: 47-89). In case of Thailand, Paxson (1996: 255-288) indicated that the income and consumption profile appear to track each other as in the U.S, Britain, and Taiwan which she also studied. However, she shows additionally that the peaks in income and consumption occurred later in Taiwan and Thailand than in the U.S and Britain (Paxson, 1996: 270).

Browning and Crossley (2001: 12) summarized a number of alternative explanations for this evidence; for example, households may be rule of thumb consumers (Carroll and Summer, 1991), the existence of liquidity constraints (Thurow, 1969: 324-330), households are prudent (Nagatani, 1972: 344-353), the substitutability between consumption and leisure (Hackman, 1974: 188-194), and the presence of children in the family (Browning, Deaton, and Irish, 1985: 503-544). With these explanations, it may possible that one of these explanations may account for the empirical fact of the life cycle model of Thai agricultural households. This leaves nonetheless work for the future.

We find also that household members whose age is greater than 60 are also a positive significant, but its magnitude is less than both household members whose age is 12 to 17 and whose age is 18 to 60. This may be another inconsistency with the LCH, in which elders should consume more than the young generation. However, there may be an explanation for this evidence. It is possible that elders are more concerned about their offspring’s future, especially after Thailand’s crisis in 1997, and thus they save more and consume less at the bequest of their offspring.

The importance of bequest motives has been accepted for a long time since the contribution of Kotlikoff and Summers (1981: 706-732), although the pure life cycle model states that wealth must be clearly declining after retirement, and at a sufficiently fast pace to reach exhaustion at the end of life (Modigliani, 1988: 23)\(^74\), and Modigliani contended that the absence of a bequest motive was not critical to the heart of his model (Dynan, Skinner, and Zeldes, 2002: 274). Gale and Scholz (1994:

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\(^74\) Most studies have concluded that the wealth of a given cohort tends to decline after reaching its peak at the age range of 60-65 or somewhat beyond it, and in any event after retirement (see the example of these studies in Modigliani, 1988: 23)
145) indicated that there are two main sources of wealth acquired by households: life-cycle savings and transfer savings which are composed of an inter vivos transfer (i.e. a transfer between living people) and a bequest transfer (i.e. a transfer that occurs at the death of the donor). They strongly rejected the simple life cycle model. By using micro data, they estimated that bequests account for 31% of net worth. Actually, apart from Gale and Scholz (1994: 145-160), several studies have supported the importance of bequest in the life-cycle model. These include, for example, Menchik and David (1983: 672-690), Kotlikoff (1988: 41-58) and Dynan et al. (2002: 274-278). Menchik and David (1983: 672-690) give two reasons why people could be accumulating in old age. First, the bequest motive is strong, and may become stronger, as they age. Second, persons become more and more averse to risk as they age. This is also supported by a study of Dynan et al. (2002: 274-278), which indicated that allowing for uncertainty in life-cycle models can resolves the controversy over the importance of life-cycle and bequest savings by showing that these motives for saving are overlapping and cannot generally be distinguished. More specifically, a dollar saved today simultaneously serves both a precautionary life cycle function and bequest function. Therefore, with the support of these studies, especially those of Menchik and David (1983: 672-690) and Dynan et al. (2002: 274-278), our estimated life-cycle model might show currently both evidence of precautionary motives and bequest motives. Nevertheless, further study should be done to investigate the existence of the bequest motive.

For idiosyncratic and aggregate shock, we find only the impact of aggregate shocks on household consumption. Village (tambon)-year dummy variables are statistically jointly significant at the 1% level in all of the region groups. This implies that an aggregate shocks were significant determinants of household consumption, while this is not true for household head illness.

We also separate the consumption equations for each region as with an estimation of income equations. The fixed effect consumption regression is shown in

table 4.4. For each region, some supportive evidence appears for the PIH only in the Central Eastern and Western region group. The estimator propensity to consume out of transitory income in this region closes to zero, and is statistically significant at the 1% level even though permanent income is insignificant. We find no evidence of either transitory or permanent income in other regions except for the significant impact of unexplained income in every region. This implies that only agricultural households in the group of Central, Eastern and Western regions are unable to smooth their consumption in the face of income shock due to rainfall variation, but vice versa for other regions.

There are several plausible explanations for this evidence. First, there has been a high financial development in the Thai economy since 1986. Both formal institutions such as commercial banks, noncommercial banks, finance and insurance companies, saving and agricultural cooperatives, credit unions and quasi-formal institutions\(^{76}\), such as saving groups, production credit groups, rice banks, women’s groups, and buffalo bank have greatly increased either their setting up new institutions or expanding new branches. An increase in these financial intermediations, especially for the quasi-formal institutions, will help to increase the accessibility of financial sources for agricultural households. This explanation is also supported by a study of Kaboski and Townsend (2005: 1-50) in which they found that quasi-formal institutions can help Thai rural households smooth their consumption in the face of income shocks. Second, Thai agricultural households may implement several informal insurance mechanisms such as drawing savings, selling assets, an increasing work hours, off-farm working, diversifying crops, reciprocal gifts and loan and risk sharing in the community. These mechanisms are important tools for the poor in managing shocks since they can provide protection from shocks in some ways. Among several mechanisms, many studies have found the implementation of some mechanisms on Thai households. These include those of Paxson (1993: 15-33), Townsend (1995: 83-102), Paulson (2000: 1-29), Songporne Tongruksawattana, Waibel and Schmidt (2010: 1-20), Ornsiri Rungruxsirivorn (2007: 1-15), and Rigg and Salamanca (2009: 255-270).

\(^{76}\) Quasi-formal institutions are the institutions that keep records and often have bank accounts, but do not in general have their own office (Kaboski and Townsend, 2005: 6).
Table 4.4 Fixed Effect Consumption Regressions (each region)

<table>
<thead>
<tr>
<th>Regions:</th>
<th>Northern</th>
<th>Southern</th>
<th>Northeastern</th>
<th>Central, Eastern and Western</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variables</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transitory income</td>
<td>-0.158 (0.159)</td>
<td>-0.197 (0.198)</td>
<td>0.143 (0.095)</td>
<td>0.223 (0.095)**</td>
</tr>
<tr>
<td>Permanent income</td>
<td>-0.013 (0.101)</td>
<td>0.081 (0.144)</td>
<td>-0.034 (0.127)</td>
<td>0.133 (0.104)</td>
</tr>
<tr>
<td>Unexplained income</td>
<td>0.084 (0.018)**</td>
<td>0.088 (0.031)**</td>
<td>0.086 (0.036)**</td>
<td>0.059 (0.030)**</td>
</tr>
<tr>
<td>Variance of income</td>
<td>-6.92e-09 (2.96e-09)**</td>
<td>3.75e-07 (3.37e-07)</td>
<td>-3.30e-08 (1.71e-08)**</td>
<td>-8.61e-06 (8.21e-06)</td>
</tr>
<tr>
<td>Head_illness</td>
<td>-4821.154 (12565.910)</td>
<td>-6653.657 (23614.620)</td>
<td>7954.240 (8470.409)</td>
<td>-31784.830 (19313.990)</td>
</tr>
<tr>
<td>Members 0_5</td>
<td>10645.130 (9893.825)</td>
<td>9169.077 (13106.250)</td>
<td>6150.782 (4718.764)</td>
<td>-3110.240 (9588.175)</td>
</tr>
<tr>
<td>Members 6_11</td>
<td>16954.530 (8851.143)**</td>
<td>4349.393 (13703.410)</td>
<td>11859.760 (4411.640)**</td>
<td>6075.693 (11073.100)</td>
</tr>
<tr>
<td>Members 12_17</td>
<td>25453.710 (9516.504)**</td>
<td>613.988 (11657.490)</td>
<td>2039.040 (4678.986)**</td>
<td>23843.750 (7594.889)**</td>
</tr>
<tr>
<td>Members 18_60</td>
<td>26259.730 (5494.277)**</td>
<td>22851.340 (9866.534)**</td>
<td>25820.180 (4552.353)**</td>
<td>17905.540 (5377.766)**</td>
</tr>
<tr>
<td>Members 61_up</td>
<td>28078.360 (8395.440)**</td>
<td>6348.845 (16475.830)</td>
<td>11706.190 (7282.941)</td>
<td>19598.520 (11280.900)**</td>
</tr>
<tr>
<td>Cons</td>
<td>13673.500 (18100.630)</td>
<td>-15549.700 (148288.600)</td>
<td>-9119.844 (12255.58)</td>
<td>76083.200 (38940.440)**</td>
</tr>
<tr>
<td>Number of observations</td>
<td>1325</td>
<td>745</td>
<td>2819</td>
<td>759</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.206</td>
<td>0.029</td>
<td>0.160</td>
<td>0.167</td>
</tr>
<tr>
<td>Sargent-Hansen test</td>
<td>2.1e+06***</td>
<td>4.2e+04***</td>
<td>6.4e+05***</td>
<td>3.5e+04***</td>
</tr>
<tr>
<td>F-tests:</td>
<td>101.040***</td>
<td>40.530***</td>
<td>65.860***</td>
<td>68.630***</td>
</tr>
<tr>
<td>Test 1:</td>
<td>0.520</td>
<td>1.390</td>
<td>1.590</td>
<td>0.47</td>
</tr>
<tr>
<td>Test 3:</td>
<td>509.420***</td>
<td>162.400***</td>
<td>759.740***</td>
<td>59.510***</td>
</tr>
</tbody>
</table>

Notes: 1.) Robust standard errors in brackets under coefficients  
2.) * significant at 10%; ** significant at 5%; *** significant at 1% 
3.) Test 1: coefficient of YP = 1, Test 2: coefficient YT = coefficient of YP and Test 3: village-year dummies jointly insignificant.

Third, there has been a high increase in government welfare support programs (“the grass roots programs”) over the past decade, such as a debt moratorium for farmers, a people’s bank project, village-urban community funds, free education
policy, universal health care including a variety of “Ua-athorn” policies, for example, loans for cheap housing, scholarships for students from poor households, etc. Although it generally accepted that these policies have implicit political goals, they policies can increase household income and then household consumption, especially poor households even if it is just a short period of a rise of welfare. Menkhoff and Ornsiri Rungruxsirivorn (2010: 110-122) found that village funds reached the target groups of lower-income households better than formal financial institutions and helped to reduce credit constraints. This evidence is also consistent with a study of Ornsiri Rungruxsirivorn (2007: 1-15), which examined the nature of risk faced by households in Thailand and their strategies to mitigate income shocks. In this study, she found that borrowings from the village funds were the most common risk-mitigating strategy implemented by households. The helpfulness of these policies was also reaffirmed by a study of Thailand Development and Research Institution (TDRI), which studied the impact of village funds and debt moratorium policy. This study indicated that most households that obtained the benefit of these policies were poor (TDRI, 2008: 8).

In case of the group of the Central, Eastern and Western region, it can hardly be rejected that these regions are similar to other regions because of the three reasons stated above. Moreover, for some reasons such as the financial development level, the Central, Eastern and Western group also had a better level of development. Therefore, one of the plausible explanations of the inability to smooth consumption in the face of income shocks due to rainfall variance of households in these regions may be the different impact of rainfall in these regions. The geography of the Central region is mostly low plain. Thus, even if the frequency of rainfall is less than in the Southern region, if there is heavy rain or a storm, there is high opportunity of facing a flood and there is often the persistent flooding77. Additionally, in many cases, even if there is no heavy rain in this region, there is heavy rain in the Northern region, and a large quantity of water from the Northern region will often flow to this basin region and this will lead to flooding. The big flood situations which occurred in 1995, 2006, and currently in 2011 are some example of this natural phenomenon. Unlike the Central

77 The Thung Makam Yong (Kaem-ling) project is one of the examples of the remedy of the persistent flooding in this region.
region, even though there is more frequency in rainfall there, the geography of the Southern region is mostly highland and close the sea on both sides of the region. Although there is thus more frequent rainfall, the rain can drain quickly except in some plain areas. Furthermore, most crops in Southern region are rubber, which bear the rain, so the heavy rain has little impact on the households in this region. Similar to the Southern region, the geography of the Northern region is an interchange between highland and valley, while the Northeastern region has also a small basin. Therefore, even though there is the heavy rain, only some areas will face flooding. Nevertheless, the Northern and Northeastern regions usually have a short monsoon period.

Finally, apart from the empirical evidence of Jakinee Ruangthammasak (2008), which found a closing zero of the propensity to consume out of permanent income of Thai households as well as the study of Carroll (1994: 111-147) and Zhou (2003: 192-212) which found that the consumption propensity out of permanent income was always small and was sometimes negative and insignificant, Naga and Bolzani (2006: 202) indicated that there are several reasons why the marginal propensity to consume out of permanent income (MPCPI) is less than unity. First, if there exists a bequest motive, and such a good is a luxury, then the MPCPI will typically be smaller than one. Second, credit market imperfections in various forms may result in the MPCPI being different from one by forcing the consumer to depart from the optimal allocation rule. Third, the existence of a precautionary saving motive may also result in the MPCPI being smaller than one. Buffer stock saving behavior for instance induces consumers to maintain a constant permanent income to wealth ratio. Unexpected rises in permanent income induce the consumer to save (rather than to consume more) in order to maintain a constant permanent income to weather ratio. Under the standard PIH, only the expected value of lifetime wealth affects consumption, so that consumption is insensitive to perceived changes in future income risks, and thus a 1% change in permanent income causes a 1% change in consumption. However, the existence of a precautionary saving motive, which permits insensitivity of consumption to uninsurable income risks, may cause the MPCPI to be less than one since consumption may be dropped to serve buffer stocks against uncertainty. The extent to which much consumption can be reduced depends
on the degree of uncertainty of future income (i.e. consumers with greater income uncertainty, ceteris paribus have lower current consumption (Carroll, 1994: 111).

To illustrate concretely the impact of the precautionary saving motive on the MPCPI, we may recall the theoretical discussion, but adapt it slightly from Carroll and Kimball (2005: 1-52). For simplicity, Carroll and Kimball show the impact of precautionary savings in the case of two periods, and consider a consumer with initial wealth for whom it is anticipated that future income uncertainty $Y_{t+1} = \bar{Y} + \xi_{t+1}$ will be stochastic. This consumer solves the unconstrained optimization problem as follows:

$$\max_{c_t} u(c_t) + E_t \left[ V_{t+1} \left( \omega_t - c_t + \bar{Y} + \xi_{t+1} \right) \right]$$

or equivalently

$$\max_{s_t} u(w_t - s_t) + E_t \left[ V_{t+1} \left( s_t + \bar{Y} + \xi_{t+1} \right) \right]$$

The first-order condition for equation (103) and (104) will be

$$u'(c_t) = E_t \left[ V'_{t+1} \left( w_t - c_t + \bar{Y} + \xi_{t+1} \right) \right]$$

and

$$u'(w_t - s_t) = E_t \left[ V'_{t+1} \left( s_t + \bar{Y} + \xi_{t+1} \right) \right]$$

respectively.

If $u$ and $v_{t+1}$ are CRRA utility functions, we may depict the optimum level of savings and consumption of this problem as shown in figure 4.1.

Figure 4.1 shows the optimal level of savings and consumption of the two cases; that is, the perfect-certainty case and the future income uncertainty case. The upward-sloping curve of $u(w_t - s_t)$ reflects the period-$t$ margined utility of the consumption $w_t - s_t$ associated with that choice of savings. The downward-sloping curve of $V'_{t+1}(s_t + \bar{Y})$ reflects the marginal value the consumer would experience in period $t+1$ (the future marginal utility of consumption) as a function of savings $S_t$ in the previous period if she were perfectly certain to receive income $\bar{Y}$. This curve is downward-sloping as a function of $S_t$ because the more that consumers save in period

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78 This two-period model is directly applicable to the multi-period case with minor modifications.
Figure 4.1 Determining Consumption in the Two Period Case Given Initial Wealth

$t$, the more is available for consumption in period $t+1$ and thus the lower is the marginal utility of spending in $t+1$. The optimal consumption ($\hat{S}$) is found at the point of intersection between the $u'(w_t - s_t)$ and the $V_{t+1}'(s_t + \bar{Y})$ curves; that is, the level of savings that equalizes the current and future marginal utility of consumption in the case of perfect-certainty. Nevertheless, if the future income is uncertain, the utility-maximizing level of consumption is determined by the intersection of $u'(w_t - s_t)$ and $E_t[V_{t+1}'(s_t + \bar{Y} + \xi)]$, or equivalent to the optimal level of savings at the $S^*$. This indicates that when households face future income uncertainty at the $\xi_0$ level, they will reduce their consumption, and the magnitude of consumption decline is equal to the magnitude of precautionary savings, which is the amount by which savings rises from a riskless ease to a risky case ($\hat{S} - S^*_0$). Moreover, since there are several degrees of future income uncertainty, and then the prudence, in the case of households facing a higher level of uncertainty ($\xi_1$), household consumption will decrease more than the low level of uncertainty. The magnitude of precautionary
savings in this case, which is equal to $S - S^*$, reflects the decline in household consumption.

This explanation is quite consistent with our empirical results, in which we find that the coefficient of permanent income is significant but small for all region groups, while we find no a significance of permanent income in any region. Nevertheless, we find a high significant as well as a large magnitude of income uncertainty. The magnitude of coefficients ranges from -1.32e-12 to -6.92e-09. These coefficients were quite high when compared with several studies; for example, Dardononi (1991: 153-160) found that the coefficient of variance income on consumption regression about – 0.001; Chen et al. (1999: 173-183) tested consumption on several risk measurements and found that the coefficients range from -0.06 to -0.70; Meng (2003: 465-485) found a range of the coefficients of variance income from -0.01 to -2.91; and Zhou (2003: 192-212) found that the magnitude of coefficients range from -0.00003 to -0.001. When the results of these studies are compared with our results, it may be possible that finding a small and insignificant in the coefficients of permanent income of Thai agricultural households may be a result of the high degree of uncertainty in future income, as explained by the precautionary saving motive model.

Unlike the testing on all region groups, Thai agricultural households clearly exhibit precautionary motive saving behavior, in which they will consume less when they anticipate a higher variance of income in the future in order to preserve their buffer stocks against the possibility of future shock only in the Northern and Northeastern region. The coefficients of income variance are negatively significant at the 1% and 5 % level, with a large magnitude in the Northern and Northeastern region respectively.

We find that the impact of family composition on household consumption for each region is different from the analysis of the groups of regions, even if most of household members whose age is over 5 are still significant in most regions. Households in the Central, Eastern and Western group, including the Northern region, behave more consistently with the LCH, while the households in the Northeastern region still clearly contradicted the LCH. In the Central, Eastern and Western region group, household members whose age is 18 to 60 behave following the LCH, in
which they consume less than both household members whose age is 12 to 17 and whose age is over 60, while household members whose age is over 60 in the Northern region consume more than household members whose age is 18 to 60. This is consistent with the LCH, even though household members whose age is 18 to 60 still consume more than household members whose age is under 18, which contradicts with the LCH for this case. However, in sum, the consumption of Thai agricultural households seems to follow less the LCH.

We still find impact of the illness household head on household consumption in any region. On the contrary, for an aggregate shocks, the village (tambon)-year dummy variables are still statistically jointly significant at the 1% level in all region groups. This implies that aggregate shocks affect household consumption in all regions but vice versa for idiosyncratic shock.

4.2 Conclusion

The theory of life-cycle-permanent income predicts that if there are complete markets for credit, or there are other consumption smoothing mechanisms, transitory income shocks then should be smoothed away through these mechanisms, and thus they should not affect the consumption pattern. This theory is nevertheless fulfilled by the precautionary motive for the saving hypothesis, in which consumption may be permitted to drop in the face of transitory shocks in order to preserve buffer stocks against the possibility of shocks. We examine these hypotheses for agricultural households in Thailand using three-wave Thai household panel data from 2005 to 2007. We examine also households both at the country and regional level to account for the difference in rainfall variation and in main crop cultivation.

The results indicate that the consumption behavior of Thai agricultural households is less consistent with the PIH. Although we find a significant impact of transitory income shocks due rainfall variation close to zero with households at the country level, we find this evidence only in the Central, Eastern and Western region group when we examined at the regional level. Furthermore, there is no evidence of a relationship between permanent income and household consumption in any region, even if we find slight evidence for the entire country’s case. Four plausible
explanations are implemented to sort out this evidence. First, there has been higher financial development in Thailand since 1986. Second, Thai agricultural households may utilize several informal insurance mechanisms. Third, there had been a high increase in government welfare support programs (the “grass roots programs”) over the past decade. An increase in these three channels may enhance the consumption smoothing mechanisms and then protect households from transitory income shocks. Finally, we presume that the high degree of uncertainty in future income may be a cause of the small and insignificant coefficient of permanent income of Thai agricultural households.

In contrast with the evidence of the PIH, Thai agricultural households exhibit clearly the precautionary saving motives behavior both in groups of regions and at regional levels. This implies that households drop their consumption to preserve their buffer stocks against future income shock due to rainfall variation. This behavior nonetheless is not exhibited for the households in the Southern or Central, Eastern, and Western groups. We also find little evidence of the impact of the family composition on household consumption, which is consistent with the life-cycle hypothesis. For the household members whose age is 18 to 60, and who should consume less and more save, this relationship become inverted in most regions. The results show nevertheless a smaller proportion of consumption for household members whose age is 18 to 60 in the Central, Eastern and Western region group and a large proportion of consumption for household members whose age is over 60 in the Northern region, which is quite consistent with the LCH. Finally, while the aggregate shock proxied by villag-year dummy variables has a significant impact on both groups of regions and at each regional level, we find no impact of idiosyncratic shock proxied by the illness of the household head.
CHAPTER 5

EXTENSION I: CONSUMPTION SMOOTHING MECHANISMS

5.1 Introduction

As mentioned in the first chapter, households in developing countries, mainly in rural areas, often must face immense risk from both idiosyncratic and covariate shocks. Their income adheres either directly or indirectly to agriculture. Consequently, their incomes are highly uncertain as a result of weather variation, incidence of disease, pest attack, and the volatility of price. These idiosyncratic and covariate shocks may lead to consumption insecurity, and then leave some people under a minimal standard of living, which is an acute threat to people’s subsistence. However, income fluctuations are not expected to affect household consumption if credit and insurance markets are complete, or there exist alternative mechanisms for dealing with risks.

For most developing countries, nevertheless, credit and insurance markets are missing or incomplete\(^\text{79}\). Formal credit and insurance arrangements are seldom available in these countries as a result of the well-known problem of asymmetric information (Stiglitz and Weiss, 1981: 393-410). Under this circumstance, finding alternative ways to smooth out their consumption as a second-best response to market failures may be the first struggle for saving their life.

A large body of literature has indicated that households in developing countries make use of a variety of mechanisms. Alderman and Paxson (1992: 1-2) divided these mechanisms into two main strategies. One is risk management strategies (or income smoothing), which have been used to protect households from adverse income shock before they occur by making conservative production or employment

\(^{79}\) Actually, many studies showed not only developing countries face credit market imperfection but also developed countries (Ciaian and Swinnen, 2009: 1124-1125).
choices and diversifying economic activities (Morduch, 1995: 104). Another is risk-coping strategies (or consumption smoothing), which take force after shocks occur, for example, borrowings and savings, depleting and accumulating nonfinancial assets, adjusting labor supply and employing formal and informal insurance arrangements. (Morduch, 1995: 104)\(^8\). However, consumption smoothing may be very costly in circumstances characterized by difficulty in borrowings, and income smoothing thus may be more likely to take place when credit and insurance constraints bind (Kinsey, Burger and Gunning, 1998: 90).

In addition, even though both risk management and risk coping strategies are important mechanisms for the poor in mitigating the impact from shocks, these private informal mechanisms have several limitations. The poor may use these mechanisms in protection of themselves from small shocks, but not against big and persistence shocks. Additionally, some studies turned out both more costly and less the expected profit as a result of the implementation of these mechanisms (Rozenweig and Binswanger, 1993: 56-78; Rozenweig and Wolpin, 1993: 223-244; Morduch, 1995: 103-114). Furthermore, most private informal insurance mechanisms are typically weak and often provide only inadequate protection to poor households. Studies from regions as diverse as rural India, China, and Sub-Saharan Africa suggest that despite these mechanisms existing, households are exposed to considerable risks from adverse shocks and then high variability in consumption outcome remains (Dercon, 2000: 5; Morduch, 1999: 188). With these limitations, therefore, public insurance mechanisms, for example promoting savings, microcredit programs, crop and health insurances, including social security, is another mechanisms to improve poor household’s welfare even where informal insurances is well developed (Morduch, 1999: 188)\(^1\).

In the context of the Thai economy, the government of Thailand has experimented with different institutional frameworks to provide cheap credit to the

\(^8\) Due to an income smoothing take force before shock occurs, they are also called \textit{ex-ante} risk management. In contrast, consumption smoothing take force after a shock occurs is also called \textit{ex-post} risk coping strategies.

\(^1\) The possibility of crowding out existing informal insurance should not be ignored, but in most low-income countries, it is unlikely to substantially undermine steps to help poor households. First, informal insurance is often very limited, and second, the crowding out of some private actions can have valuable social benefits (Morduch, 1999: 202).
rural sector since 1916, followed by the establishment of the Bank for Agriculture and Agricultural Cooperatives (BAAC) in 1966 (see the historical brief in Ammar Siamwalla; Chirmsak Pinthong; Nipon Poapongsakorn; Ploenpit Satsanguan; Prayong Nettayarak; Wanrak Mingmancenakin and Yuavares Tubpun, 1990: 274-277). However, the result of these interventions is quite disappointing, just as with most developing countries (Hoff and Stiglitz, 1993: 33). The injection of funds into the rural areas neither lower informal sector interest rates nor drive informal lenders out of business (Ammar Siamwalla et al., 1990: 272).

However, over the past two decades, the Thai growth experience has been both qualitatively and quantitatively consistent with the models of growth and financial intermediations, which predict financial intermediation to have impacts on a household’s assets, risk sharing, occupation, entrepreneurship, and credit constraints. Both formal and informal institutions overall help reduce reliance on moneylenders, and village-level microfinance institutions loosen households’ constraints on formal credit. Despite these new circumstances, there are still important segments of Thai households with limited access to formal financial intermediations (Kaboski and Townsend, 2005: 2-4). There are two main sources of credit for households in rural and semi-urban areas in Thailand: The Bank for Agriculture and Agricultural Cooperatives (BAAC) and commercial banks. Of these two, the BAAC is much more active in rural areas (Paulson and Townsend, 2005: 36). With the moral hazard problem, which is the dominant source of constraints in Thailand (Paulson, Townsend and Karaivanov, 2006: 104), a large number of Thai households nevertheless still utilize a variety of credit sources.

Regardless of relying heavily on savings (either in the form of cash or through asset sales), Paulson and Townsend (2005: 38) group formal and informal financial arrangements for credit and insurance markets in Thailand into six categories. The first, formal institutions, includes commercial banks and finance companies. The second, village institutions and organization, incorporates production credit groups, and rice and buffalo banks. The third includes formal loans from the BAAC and the Agricultural Cooperatives. The BAAC customers whose loans are secured through joint liability arrangements make up the fourth group. Money lenders
are the fifth. Finally, rotating savings and credit associations (ROSCAs) make up the sixth group. Additionally, it is also common for households to borrow from relatives and neighbors.

In addition to the above mechanisms, as well as household savings, most of which are the primary source for consumption smoothing as well as investment, the data from the Ministry of Finance Household Debt Survey (MOF Survey) has revealed that Thai households, especially poor households, still use a variety of risk managements and risk coping mechanisms, like most households in developing countries. These include selling livestock and stored rice, cutting household expenditures, selling non-financial assets such as land and jewelry, working more hours and migrating to other places for work opportunities (Ornsiri Rungruxsirivorn, 2007: 1-16). Additionally, the MOF survey data indicate that a number of households diversify their income from various sources, which implies the use of risk management mechanisms. Furthermore, as stated earlier, despite the existence of these mechanisms, the consumption fluctuations of poor Thai household remain high. The Thai government thus has also launched various programs to broaden the household’s accessibility to credit sources as well as to improve people’s welfare, for example, village funds, people bank cash handout, sufficient economy funds and universal health care.

Despite the awareness in the importance of both private and public insurance mechanisms, surprisingly, research on the effectiveness of these mechanisms in protection of Thai households from adverse shocks is scant. Only some studies have attempted to bridge this gap. These include saving mechanisms (Paxson, 1992: 15-33), migration and remittances (Paulson, 2000: 1-29, Miller and Paulson, 2007: 1-32); and risk sharing (Townsend, 1995: 83-102). To complement this gap, therefore, this

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82 Besley (1995: 115) called institutions that make relatively little use of formal contractual obligations enforced through a codified legal system “nonmarket institutions.”

83 Gine (2010: 1-14) used the Townsend. Thai data with 2,612 sample households report that 34 percent of the sample self-finance, 17 percent borrow from formal institutions that require collateral: commercial banks, finance and insurance companies and BAAC individual loans; 18 percent borrow from formal institutions that do not require collateral: BAAC group loans, agricultural cooperative and village-level institutions; 17 percent borrow from informal lenders: moneylenders, store owners, landlords, traders including friends and relatives; and, only and 13 percent of the sample borrow from both a formal and an informal lender.

84 See also a variety of Thai household risk managements in Rigg and Salamanca (2009: 255-270).
study takes advantage of the availability of three-wave Thai household panel data which cover the years 2005 to 2007 in examining the consumption smoothing mechanism of Thai agricultural households, which are representative of poor households that are highly exposed to adverse shocks. Therefore, the objective of this extension part is to examine how Thai agricultural households smooth their consumption in the face of transitory income shock and income uncertainty through two main mechanisms that are savings, and borrowings.

This first section of this extension part is organized as follows: Section 5.2 outlines the theoretical model that underlines the empirical work, and surveys the literature on consumption smoothing mechanisms. Section 5.3 presents the methodology, which consists of empirical specifications, and the econometric techniques. Section 5.4 discusses the empirical results, while the conclusion is set forth in section 5.5.

5.2 Theoretical Framework and Literature Review

It is generally recognized that Thailand is still one of the developing countries where formal credit and insurance arrangements are incomplete as a result of the asymmetric information problem. In addition, with the limitations of the government budget, public insurance programs are also still confined. A large number of Thai households thus need to find alternative strategies to mitigate the adverse effects of shocks.

To examine how well Thai households are able to use alternative strategies for smoothing out their consumption, a theoretical model is desired. Because we focus only on the study of consumption smoothing over time through two mechanisms but not across households, we thus may model our study based on the theory of intertemporal choices, which are the basis of modern theory of consumption85. In

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85 An alternative model for testing how households use smoothing consumption mechanisms to mitigate adverse shock is the risk-sharing model (see Fafchamps and Lund, 2003: 261-287).
addition, with concern about some crucial real-world characteristics overlooked by the standard version of the Life-Cycle-Permanent Income Hypothesis (LC/PIH), this study includes the precautionary saving effect and then includes the effect of future income uncertainty in the model.

Since the main objective of this study is the investigation of how well households are able to use the consumption smoothing mechanism to mitigate transitory income shock and future income uncertainty, but not focus on either one. For simplicity, therefore, our model follows Caballero (1990: 113-136) and (1991: 855-871) by assuming that the utility function exhibits constant absolute risk aversion (CARA) to obtain a closed-form solution for consumption\(^86\).

Caballero’s basic model involves an agent with two main assumptions (Wang, 2003: 927); first, the intertemporally time-additive separable Von Neuman-Morgenstern utility where the instantaneous utility function is exponential of the form:

\[
U(C_t) = -\frac{1}{\alpha} \exp(-\alpha C_t), \tag{107}
\]

where \(U(\cdot)\) is the representative consumer’s utility function, \(C_t\) is the value of consumption in period \(t\), and \(\alpha > 0\) is the coefficient of absolute risk aversion. Second is the stochastic uninsurable autoregressive income process, which is

\[
Y_t = Y_0 + \xi_t, \tag{108}
\]
where \( Y_t \) is labor income and \( \xi_t \) is a white noise error term with mean zero and constant variance:

\[
\xi_{t+1} \sim iD\mathcal{N}(0, \sigma^2)
\]  

and then labor income follows a random walk with normally-distributed error term.

In each period the representative consumer maximizes the expected present value of lifetime utility, where it is assumed that both the interest and discount rates are constant and equal to zero. Let \( E_t \) be the expectation operator conditional on all information available to the consumer in period \( t \). Thus, at time zero, the household maximizes:

\[
E_0 \left[ \sum_{t=0}^{T-1} \frac{1}{\alpha} \exp(-\alpha C_{t+i}) I_0 \right]
\]  

subject to

\[
A_{t+i} = A_{t+i-1} + Y_{t+i} + C_{t+i},
\]  

\[
\lim_{i \to \infty} A_{t+i}(1+r)^{-i} = 0,
\]  

\[
A_{t-1} = 0,
\]

where \( A \) is nonhuman wealth and equation (112) and (113) imply that initial and terminal wealth are zero.

Under uncertainty circumstances, however, the intertemporal budget constraint (111) may be rewritten as
\[ E_t \sum_{i=0}^{T-t} C_{t+i} = A_t + E_t \sum_{i=0}^{T-t} Y_{t+i}. \quad (114) \]

Assuming that there are no liquidity constraints, a household will choose a consumption sequence \( \{C_{t+i}\}_{i=0}^{\infty} = 0 \) that maximizes (110) subject to (114) by using dynamic optimization.

The Euler equation of the optimization problem is

\[ \exp(-\alpha C_t) = E_t[\exp(-\alpha C_{t+1})]. \quad (115) \]

Using the Euler equation (115) and moment-generating function concept, the consumption path is yielded as

\[ E_t(C_{t+1}) = C_t + \frac{1}{2}\alpha \sigma^2 \quad (116) \]

\[ C_{t+1} = C_t + \frac{1}{2}\alpha \sigma^2 + \epsilon_{t+1}. \quad (117) \]

Replacing the stochastic process of consumption and income in the intertemporal budget constraints yields the consumption function of the form:

\[ C_t = \frac{1}{(T-t+1)} A_t + Y_t - \frac{1}{4}(T-t)\alpha \sigma^2. \quad (118) \]

According to Caballero’s approach, it should be noted that the slope of the expected consumption path equation (116), rather than being equal to zero as under certainty equivalence, is positive and constant; it depends both on the degree of absolute prudence \( \alpha \) and the variance of income change \( \sigma^2 \). While the
consumption function equation (118), depends not only on the certainty equivalent component but also the degree of uncertainty, the degree of prudence and the horizon (Blanchard and Mankiw, 1988: 175).

To implement the consumption function in modeling the consumption smoothing mechanism, it may be more simple if we rewrite equation (118) in simple form following Guiso, Jappeli and Terlizzese (1992: 318) as

\[ C_i = \theta L_i - u \sigma_i^2. \]  

(119)

In this case, household consumption is the sum of two components. The first is a fraction \( \theta \) of the certainty equivalence level of lifetime resources \( L \), which is the sum of human wealth and nonhuman wealth; the second is the precautionary component, which, under the normality assumption, is proportional to the variance of the earnings shocks.

Combining equation (119) with the identity (120):

\[ S_i = Y_i - C_i, \]  

(120)

gives us the first model for testing the consumption smoothing mechanism; that is, saving model or self insurance mechanism:

\[ S_i = Y_i - \theta L_i + \mu \sigma_i^2. \]  

(121)

With this equation, it should be noted that savings is high when current income is higher than permanent income that is when transitory income is high. Contrarily, when current income is less than its average, savings are negative. This indicates that households use savings to smooth their consumption in the face of changes in their transitory income.
By assuming that other mechanisms are equivalent to the saving mechanism in smoothing consumption, this paper presents another consumption smoothing mechanism against adverse shock:

\[ B_i = Y_i - \theta L_i + \mu \sigma_i^2 \]  

(122)

Equation (122) is a borrowing mechanism. With these two models, it should also be noted that these two mechanisms respond not only to transitory income shocks but also the variance in income shocks.

In general, the literature on consumption smoothing mechanisms over time through saving behavior, borrowings in formal and informal markets, accumulating and selling assets etc., is prolific. This literature nevertheless is mostly based on the standard version of the LC/PIH. The literature based on the extend version of the LC/PIH, which includes the precautionary saving motive in the model, is scant, with the exception of the saving model. To review this literature, it can be divided into two main categories; first, the literature that is based on the standard version of the LC/PIH; second, the literature that is based on the extended version of the LC/PIH. In addition, each category may separately test either the saving mechanism or other mechanisms.

Much of the literature is based on the standard version of the LC/PIH and focuses on the saving mechanism. For example, Paxson (1992: 15-33) used three cross sections of income and expenditure data on Thai rice farms drawn from the 1975/76, 1781 and 1986 Thai Socio-Economic Surveys (SES) to estimate the response of savings to transitory income. The results show that propensities to save out of transitory income due to rainfall shocks are quite high. This implies that savings are used to buffer consumption from income shocks. Udry (1995: 1287-1300) examined the hypothesis that households dissave when confronted with adverse shocks to their income using a nine-round survey of 200 farming households in northern Nigeria. He found evidence to support this hypothesis. Households in northern Nigeria use overall savings, grain savings, and each savings, with the exception of livestock savings as buffer stocks, as one component of an ex post risk-
coping strategies. Alderman (1996: 343-365) adapted the approach of Paxson (1992: 15-33) to study household savings and consumption smoothing in rural Pakistan. The results showed that households use several types of savings to cushion transitory shock, although consumption smoothing mechanisms appear to break down under repeated shocks. Kochar (2004: 257-285) examined the effect of adult health on the savings and portfolio decisions of rural Pakistani households by analyzing the means where ill-health affects savings and portfolio choices. He found that expected changes in ill-health increase household savings due to the loss in income which accompanies ill-health. In addition, his results revealed also that the effect of ill-health on the rate of return on productive assets causes households to reduce investments in productive assets used in farm production.

Similarly, there is a large amount of literature on consumption smoothing over time through other mechanisms rather than savings, and the studies contained therein are based on the standard version of the LC/PIH. Rosenzweig and Stark (1989: 905-926) used longitudinal South Indian village data to examine consumption smoothing through migration and marriage. They found that marriage cum migration contributes significantly to a reduction in the variability of household food consumption. Kochar (1995: 159-164) studied the relative effectiveness of credit and the labor market in mitigating the effects of both idiosyncratic crop income shocks and sickness shocks and the dependence of these methods on the number of able-bodied males and females in the households in rural India. The regression results indicated that small negative crop shocks evoke a significant increase in wage income, while informal borrowing is not used to compensate for negative crop income shocks. For sickness shocks of males at peak periods, however, households used both wage income and informal borrowing to mitigate these shocks. Fafchamps, Udry, and Czukas (1998: 273-305) examined the behavior of households in the west African semi-arid tropics in responding to drought shock. They found that livestock transaction played less of a consumption smoothing role than is often assumed.

Jacoby and Skoufias (1997: 311-335) used panel data from rural India to examine the response of human capital investment in children to fluctuations in family income. The main result revealed that child labor, and thereby school attendance, appears to play a significant role in the self-insurance strategy. Kochar
(1999: 50-61) estimated the responsiveness of the market hours of work of Indian farm households to idiosyncratic or household-specific shocks to crop income using longitudinal data collected by the International Crop Research Institute of the Semi-arid Tropics (ICRISAT) for farm households in central India. He found that households increase the market hours of work of their male numbers in response to unanticipated variations in crop profits, while there was little significant effect on the market hours of the work of females. Paulson (2000: 1-29) examined whether the location choices of migrants that remit are consistent with the desire to mitigate the risk faced by the remitting and the receiving households using cross-sectional household data from the 1988 SES, combined with time series information on rainfall and GDP for each of Thailand’s 73 provinces over the period 1978 to 1987. The results indicated that insurance motives played an important role in explaining migration patterns and thus remittances were seen to be an important source of protection against adverse events for the receiving household.

By using panel data on rural Indian farm households to test for ex-ante and ex-post labor supply responses to weather risk. Rose (2001: 371-388) found that ex-ante, households facing riskier distributions of rainfall were more likely to participate in the labor market, while ex-post, unexpectedly bad weather and low rainfall increased labor force participation. Unlike most literature which focuses on consumption smoothing as a result of weather shocks, Goh, Kang and Sawada (2005: 239-254) employed five-year household panel data to investigate how Korean households cope with negative shocks from financial crises. They found that private transfers act both as an ex-ante risk managing mechanisms and as ex-post coping mechanisms. They found also that, before a crisis, households use credit to smooth consumption of children’s education, and medical and children services, but vice-versa during the crisis. Instead of using credit, households changed the composition of their consumption bundles by cutting back on the consumption of luxurious and durable goods during the crisis. However, they did not find evidence of households liquidating their assets to cushion the shortfall in consumption during the crisis. Kazianga and Udry (2006: 413-446) examined the extent to which livestock, grain storages, labor response and inter household transfers are used to smooth consumption against income risks in rural Burkina Faso. They found little evidence of consumption
smoothing either over time or across households within villages. The small amount of consumption smoothing that they found was affected largely through the accumulation and decumulation of stocks of grains.

Beegle, Dehejia and Gatti (2006: 80-96) using data from a household panel survey in Tanzania to examine the relationship between household income shocks, child labor, and household asset holding. Their results showed that crop shocks led to a significant increase in the level of child labor, while the level of household asset holdings decreased in response to shocks consistent with a buffer stock interpretation. Hoddinott (2006: 301-321) investigated shocks and their consequences by using longitude data from rural Zimbabwe. His results revealed that drought shocks cause some households to draw down assets. More specifically, households with more than two oxen or cows were much more likely to sell than households with one or two oxen or one or two cows. By using the body mass index (BMI), he found also that adult men were not adversely affected by this shock while adult women were adversely affected, but recovered relatively quickly. Duryea, Lam and Levison (2007: 188-214) studied the impact of household economic shocks on children’s employment and schooling using longitudinal employment survey data in Brazil. Their probit regressions showed that an unemployment shock significantly increases the probability that a child will enter the labor force, drop out of school, and fail to advance in school. Miller and Paulson (2007: 1-32), using 1988 and 1990 Thai SES data examined two issues related to gambling, risks, and informal insurance. The first result showed that households adjusted their remittances to account for unexpected shocks, while the second revealed that the likelihood and the amount of gambling increased with the quality of informal insurance. This second result thus implies that better insurance leads households to make less conservative choices. Songporne Tongruksawattana, Waibel, and Schmidt (2010: 1-21) used a panel survey of households in three peripheral provinces in Northeast Thailand to examine the relationship between shocks and coping strategies. Their results showed that a large share of households suffered mainly from ecological shock, health shocks, and economic shocks. Consequently, the households used a variety of strategies to lessen these shocks. Nevertheless, implementing these strategies depends on the people’s wealth status and the severity of shock. In response to shock incidences, they showed
that households utilize the four different coping strategies; that is, transfers and remittances, resource reallocation, borrowings and using savings and selling assets.

Since households save not only for transitory current income shocks but also for future income shocks, a large amount of literature which examines the relationship between savings (precautionary savings) and future income shocks, and is based on the extend version of the LC/PIH, has been yielded. Lusardi (1997: 319-326) used the subjective data on earnings variance provided in the Italian Survey of Household Income and Wealth (SHIW) to examine the impact of earning variance on saving. The empirical results showed that the coefficients of the subjective earning variance were statistically significant and precisely estimated. The estimated coefficients nonetheless were small. Kazarosian (1997: 241-247) tested for the precautionary motive for saving using panel data. He found that income uncertainty had a positive effect on the wealth to permanent income ratio. However, this precautionary motive varies in size depending on occupation. Lusardi (1998: 449-453), using the Health and Retirement Study (HRS), also indicated that the variance of income has a role in explaining saving and wealth accumulation of people close to retirement.

Engen and Gruber (2001: 545-579), using household-level data from the Survey of Income and Program Participation (SIPP), tested for the precautionary motive as a result of exogenous variation in income risks across individuals that arose from the unemployment insurance system. Their results supported the premise that the precautionary motive is an important determinant of individual savings behavior. More specifically, the unemployment insurance system diminishes household asset accumulation. Irvine and Wang (2001: 233-258) found that earnings uncertainty has a significant impact upon the saving pattern over the lifecycle: greater income uncertainty induces individuals to save greater amounts early in their lifecycle, but that there may be reversion in savings patterns later in the working life. Chou, Liu and Hammitt (2003: 1873-1894) estimated the effect of National Health Insurance on precautionary savings using micro data in Taiwan. They found that government provision of universal health insurance has a considerable relation with private savings.

Unlike the literature that is based on the precautionary saving motive and focuses only on the investigation of the relationship between earning uncertainty and
savings, the literature which is based on precautionary savings but focuses on other mechanisms is scant. Jalan and Ravallion (2001: 23-49) were among those that did focus on this. They used household panel data from rural India to study portfolio and other behavioral responses to idiosyncratic risks. They found some evidences that liquid wealth is held as a precaution against risks to income and food grain yields, where school enrollment appears to be protected from medical risk. In addition, they found a sizable negative effect of income risks on the out migration of labor. The relationship between labor supply and uncertainty, which is known as precautionary labor supply, is another one. Nevertheless, even though there is not as much as saving mechanism, several economists have tried to investigate how labor supply responds to wage uncertainty. Low (2005: 945-975) approximated and simulated the effect on the life-cycle behavior of uncertainty and of flexibility in labor supply. He found that flexibility in work hours allows individuals to work harder before shocks are realized so that they have more income available to self-insure. In addition, flexibility in work hours allows individuals to react to shocks to wages by changing their hours of works and thus reduce the cost of uncertainty. He also found that uncertainty induces individuals to work longer hours and to consume less when young relative to the certainty case so that they have savings, which can act as a buffer against future wage shocks.

Parker, Belghitar and Barmby (2005: 190-207) used a sample of PSID data on self-employed American working-age males to investigate the effect of wage uncertainty on the labor supply of self-employed workers. They used the standard deviation of past wages as a proxy of wage uncertainty and then examined its effect on labor supply. Their results showed that male self-employed labor supply responded to greater uncertainty by working longer hours. Consistently with Low (2004: 945-975), who found that uncertainty raises the labor supply of young agents, Floden (2006: 721-737) found that labor supply flexibility tends to raise savings when future wages are uncertain and that future wage uncertainty tends to raise current labor supply and future leisure. Nevertheless, there is not a consensus on the relationship between labor supply and uncertainty. Eaton and Rosen (1980: 365-374) have shown that there is ambiguity in the response of labor supply to uncertainty and that future labor supply can increase in response to increased wage uncertainty if risk
aversion is sufficiently high. As with Eaton et al. (1980: 365-374), Hartwick (2000: 319-325) examined the elasticity of substitution between consumption and leisure and in order to see when increased wage uncertainty led to more labor supplied. His result indicated that it is as not obvious that increased wage uncertainty *per se* leads to more labor supplied.

Among the scant literature based on both the standard version of the LC-PIH and the precautionary saving model, Kazianga and Udry’s (2006: 413-446) was a primary study that combined both models to examine the relationship between savings and permanent income, and transitory income and income variance. Their empirical results showed a positive response of savings to three types of income.

The investigation of consumption smoothing over time through various mechanisms is not only based on two main models but also on the risk sharing model. Fafchamps and Lund (2003: 261-287), using household-level data, examined the risk-sharing behavior of rural households in the Philippines by investigating whether asset sales, gifts, and informal loans served to efficiently share risk. The results indicated that shocks have a strong effect on gifts and informal loans, but little effect on the sale of livestock and grain. In addition, mutual insurance did not appear to take place at the village level. However, households received help primarily through networks of friends and relatives. Yang and Choi (2005: 1-23), adapting work of Fafchamps and Lund (2003: 261-287), examined how remittances set by overseas migrants responded to income stocks experienced by Philippine households. By using rainfall shocks to instrument for changes in household income, they found that changes in income due to rainfall shock led to changes in the remittances of the opposite sign in case of households with members that were overseas migrants. In contrast, changes in income had no effect on remittances receipts in households without overseas migrants. Based on monthly data from a panel of households in Bulgaria in 1994, Skoufias (2004: 328-347) investigated the extent to which households were able to protect their consumption from fluctuations in real income. He found that consumption is only partially protected from idiosyncratic fluctuations in income. Specifically, households smooth generally food consumption by adjusting their non-food expenditures and by borrowings through formal and informal credit markets. He found nonetheless that inter-household transfers played a limited role in insuring
consumption. In addition, his results showed that the extent of consumption smoothing varies across regions and across household characteristics; meanwhile, food consumption appeared to be less protected from changes in food prices than changes in household income. Islam and Maitra (2012: 232-243) investigated the potential role of microcredit in enabling households to insure consumption against health shocks with three rounds of a household-level panel data set from Bangladesh. They found that households that had borrowed from microcredit organizations appeared to be better able to cope with health shocks. By using livestock trade as the primary instrument, households that had access to microcredit did not need to sell livestock to the extent that households did not have access to microcredit needed to, in order to insure consumption against health shocks.

5.3 Methodology

This section presents two subsections for implementing the theory with empirical testing: empirical specifications and the econometric techniques.

5.3.1 Empirical Specifications

Since testing for how well households use consumption smoothing mechanisms to mitigate adverse shocks is based on the extended version of the LC-PIH, which combines the standard version of the LC-PIH and the precautionary saving model in the previous section. Following Kaziangana and Udry (2006: 413-446) and Jalan and Ravallion (2001: 23-49), an empirical model based on equation (121) and (122) can be expressed primarily as follows:

\[
S_{irt} = \alpha_0 + \alpha_1 Y_{irt}^p + \alpha_2 \sigma_{iy}^2 + \alpha_3 L_{irt} + \alpha_4 S_{irt} + \lambda_i + \varepsilon_{irt} \quad (123)
\]

\[
B_{irt} = \gamma_0 + \gamma_1 Y_{irt}^p + \gamma_2 \sigma_{iy}^2 + \gamma_3 L_{irt} + \gamma_4 S_{irt} + \lambda_i + \varepsilon_{irt} \quad (124)
\]
where $S_{irt}$ and $B_{irt}$ are savings and borrowings of farm households $i$ in region $r$ at time $t$ respectively, $Y_{ir}^p$ is permanent income, $\sigma^2_{ir}$ is earning uncertainty, $L_{ir}$ is the lifecycle factors which follow Paxson’s classifications (Paxson, 1992: 15-33), $IS_{irt}$ is an idiosyncratic shock proxied by household head’s illness, $\lambda_i$ is household fixed effect and $\epsilon_{irt}$ is an error term.

However, in order to implement an empirical test for this model, two main stages of works have to be developed. First, as usual with the study of consumption smoothing mechanisms, we may decompose household income into two main components: permanent and transitory income. At this point, this paper follows the approach of Fafchamps, Udry, and Czukas (1996: 273-305); Jacoby and Skoufias (1997: 311-335) and Kazianga and Udry (2006: 413-446).

We first set up a household income model as follows:

\[
Y_{irt} = \eta_1 X_{ir} + \eta_2 R_{rt} \otimes Q_{ir} + \xi_{rt} + \lambda_i + u_{irt}, \tag{125}
\]

if we nevertheless define $\xi_{rt} = \eta_1 R_{rt} + \omega_{rt}$ and assume that $\omega_{rt}$ is uncorrelated with $X_{ir}$ and $Q_{ir}$. Equation (125) then can be rewritten as

\[
Y_{irt} = \eta_1 X_{ir} + \eta_2 R_{rt} \otimes Q_{ir} + \eta_3 R_{rt} + \lambda_i + (\omega_{rt} + u_{irt}), \tag{126}
\]

where $Y_{ir}$ is the household income, $R_{rt}$ is the deviation of rainfall from the long-run regional mean and this deviation squared, $Q_{ir}$ is farm characteristics that are determinates of income, such as the demographic structure of the household and detailed information on its landholding and their quality (Fafchamps, Udry and Czukas, 1996: 288), $\xi_{rt}$ is a village year fixed effect, $\otimes$ is the kronecker product, and $U_{ir}$ is a random component consisting of unobserved factors affecting income change and measurement error.
Decomposing then $Y_{irt}$ we have permanent income, transitory income, and an unexplained income equation as presented in equation (127), (128), and (129) respectively:

\[
Y^P_{irt} = \hat{\eta}_1 X_{irt}, \quad (127)
\]

\[
Y^T_{irt} = \hat{\eta}_2 R_{rt} \otimes Q_{irt} + \hat{\eta}_3 R_{rt}, \quad (128)
\]

\[
Y^U_{irt} = Y_{irt} - \hat{\gamma}^P_{irt} - \hat{\gamma}_{irt}, \quad (129)
\]

Second, since our model is not only concerned with the impact of the first of the first moment of income shocks as a usual test for the LC-PIH but also with higher moments of income shocks. Therefore our second task is formulating this income uncertainty.

Even though there are several candidate uncertainty measurement, for example, Guiso, Jappelli, and Terlizzese (1992: 307-337) formulated income variance from direct survey questions; Carroll and Samwick (1998: 410-419) used the variance of income and the variance of log income from observed income processes to proxy for income uncertainty, and Engen and Gruber (2001: 545-579) applied the variations of unemployment insurance as a proxy for income uncertainty, this study follows Kazianga and Udry’s technique (Kazianga and Udry, 2006: 434) due to the restriction of the short panel data used in this study. Formulating income uncertainty with panel data is usually an appropriate technique for studying the precautionary saving behavior of households. Short panel data nevertheless are too short to measure for data dispersion, especially regarding variance of income.

By assuming that households have rational expectations concerning the distribution of income shocks due to the rainfall that they can expect, Kazianga and Udry estimate income variance with the time series of rainfall variation, interacted with household land characteristics weighted by the estimates from equation (126) as the following formula:
\[ \hat{\sigma}^2\left(y_{irt}^T + 1\right) = \frac{1}{16} \sum_{t=1988}^{2004} \left[ \hat{\eta}_2 \tilde{R}_{rt} \otimes \overline{O}_{irt} + \hat{\eta}_3 \tilde{R}_{rt} \right]^2, \]  

(130)

where \( \hat{\sigma}^2\left(y_{irt}^T + 1\right) \) is the estimated income variance, \( \tilde{R}_{rt} \) is historical rainfall data, and \( \overline{O}_{irt} \) is the land characteristic data from the sample households during the panel data period or equivalent to

\[ \overline{O}_{ir} = \frac{1}{3} \sum_{t=2005}^{2007} O_{irt}. \]  

(131)

To estimate the variance of rainfall-induced income shocks, estimates \( \hat{\eta}_2 \) and \( \hat{\eta}_3 \) from equation (126) were merged with historical rainfall data and the land characteristics from the sample households.

Finally, after substituting these estimated variables into equation (123) and (124), we have the final empirical specifications as follows:

\[ S_{irt} = \alpha_0 + \alpha_1 \hat{y}^P_{irt} + \alpha_2 \hat{y}^T_{irt} + \alpha_3 \hat{y}^U_{irt} + \alpha_4 \hat{\sigma}^2_{iy} + \alpha_6 L_{irt} + \lambda_i + \epsilon_{irt}. \]  

(132)

\[ B_{irt} = \gamma_0 + \gamma_1 \hat{y}^P_{irt} + \gamma_2 \hat{y}^T_{irt} + \gamma_3 \hat{y}^U_{irt} + \gamma_4 \hat{\sigma}^2_{iy} + \gamma_6 L_{irt} + \lambda_i + u_{irt}. \]  

(133)

Following the LC-PIH and the precautionary saving model, we should expect \( \alpha_1, \alpha_2, \gamma_1, \gamma_2 > 0 \), while \( \alpha_4 \) and \( \gamma_4 \) should also be positive, implying that households may either save or borrow more when they face future income uncertainty.
5.3.2 Econometric Techniques

Apart from the linear panel data model, which was previously explained, this study also uses nonlinear panel data for testing the borrowing mechanism in equation (133). The nonlinear panel data model was implemented for this equation since borrowings, which is our dependent variable, is a mixture of zero and positive value among observations. Observations with zero value are known as censored observations, and then if the dependent variable is censored for a significant fraction of the observations, the parameter estimates detained by the conventional regression model (e.g. OLS) are biased. However, consistent estimates can be obtained using the method proposed by Tobin (1954: 24-36). This approach is usually called the “Tobit model” and is a special case of the more general censored regression model.

In Tobit model, individual-specific, time-invariant effects are modeled as random effects because a fixed effect model is affected by the incident parameter problem (Neyman and Scott, 1948: 1-32). We may transform the standard linear Tobit model to the panel data Tobit model with random effect as

\[
y_{it} = \begin{cases} 
\beta' x_{it} + y_i + \varepsilon_{it} & \text{if } \beta' x_{it} + y_i + \varepsilon_{it} > 0, \\
0, & \text{otherwise}
\end{cases}
\]

for \( i = 1,2,...,N \) and \( t = 1,2,...,T \) where \( \beta \) and \( x_{it} \) are \( k \times 1 \) column vectors, \( \varepsilon_{it} \) is distributed \( N(0,\varepsilon^2) \) and \( v_i \) is distributed \( N(0,\sigma^2_v) \). In addition we assume that

\[
E(v_i v_j) = 0, \quad E(v_i \varepsilon_{it}) = 0, \quad E(\varepsilon_{it} \varepsilon_{jt}) = 0, \quad \forall i \neq j \quad \text{and} \quad d_{it} = 0 \quad \text{for censored observations and} \quad d_{it} = 1 \quad \text{for uncensored observations.}
\]

The likelihood contribution for each individual \( i \), marginalized with respect to the random effect \( v_i \) is

---

\(^{87}\) The incidental parameters problem yields an inconsistency in the estimated coefficients unless the number of time periods approaches infinity for individual \( i \).
\[ \ell_{it} = \frac{1}{\sigma_\varepsilon} \int_{-\infty}^{\infty} \phi \left( \frac{y_{it} - \beta' x_{it} - v_i}{\sigma_\varepsilon} \right) d_{it} \]

\[ \cdot \Phi \left( -\frac{\beta' x_{it} - \nu_i}{\sigma_\varepsilon} \right)^{1 - d_{it}} f(v_i, \sigma_i) dv_i, \quad (135) \]

where \( \phi(\cdot) \) and \( \Phi(\cdot) \) are respectively the probability density function (pdf) and the cumulative distribution function (cdf) of the standard normal distribution, and \( f(v_i, \sigma_i) \) is normal density with mean \( v_i \) and standard deviation \( \sigma_i \).

Due to the adding of \( v_i \) to the model, the likelihood function becomes somewhat more complicated than that of a simple Tobit model because the distribution of the unobserved component of the model for any one observation is linked through \( v_i \) to the unobserved components of all the other observations in the same cross-sectional unit. In general, for \( T_i \) observations belonging to individual, \( i \) we have the following likelihood function, \( P_{v_i|y_i} \):

\[ L_i = \int_{-\infty}^{\infty} \left[ \prod_{t=1}^{T_i} \frac{1}{\sigma_\varepsilon} \phi \left( \frac{y_{it} - \beta' x_{it} - v_i}{\sigma_\varepsilon} \right) \right] d_{it} \]

\[ \cdot \Phi \left( -\frac{\beta' x_{it} - \nu_i}{\sigma_\varepsilon} \right)^{1 - d_{it}} f(v_i, \sigma_i) dv_i. \quad (136) \]

The likelihood function for the whole sample is simply the product of the \( L_i \)'s over the \( N \) cross-sectional units, and the log likelihood is

\[ L = \sum_{i=1}^{N} \ell n(L_i) \quad (137) \]
Note that the log likelihood in equation (137) does not collapse in a sum, as it would in the case of a time-series or cross-sectional Tobit model. This is because the likelihood function for a given cross-sectional unit (equation 136) is an integral of a product instead of just a product. The log operator cannot be carried through the integral sign, so the natural log of the likelihood function in equation (137) is the sum of log the integral in equation (136). We can calculate the integrals in the log-likelihood function using the Gauss-Hermite quadrature (see Cameron and Trivedi, 2005: 786) and then maximize this log-likelihood function using standard non-linear optimization algorithms (see Butler and Moffit, 1982: 761-764). Alternatively, the log-likelihood function can be maximized using the method of the Maximum Simulated Likelihood (MSL), which allows some flexibility in the specification of the disturbance terms (see Cameron and Trivedi, 2005: 786).

5.4 Empirical Results

This section presents the empirical analysis of the testing of the implementation of the two consumption smoothing mechanisms of Thai agricultural households in response to adverse shocks and future income uncertainty, which is the focus of this study. As explained in the previous chapter, to test our hypothesis, we need to generate transitory, permanent, and variance of income from the estimated income equation at the first stage. However, the income equation for this paper is the same as that used in our previous essay, and it has already been estimated as well as analyzed. In order to make this empirical analysis concise, those generated incomes were adopted from the previous study and then implemented to test the hypothesis by following the model specification, as explained in the previous section. Two consumption smoothing mechanisms were tested separately. In addition, each mechanism was examined both at group of regions and regional level due to a concern regarding the difference in rainfall and main crop cultivation in each region.

5.4.1 Saving Equation Estimation

Table 5.1 presents the fixed effect saving regression for group of regions since the Sargent-Hansen test reports the 1% level of significance for every group of
### Table 5.1 Fixed Effect Saving Regressions (group of region):

**Dependent variable: Savings**

<table>
<thead>
<tr>
<th>Regions</th>
<th>All regions</th>
<th>All regions except southern region</th>
<th>Northern and Northeastern regions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Variables</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transitory income</td>
<td>0.698</td>
<td>0.815</td>
<td>0.947</td>
</tr>
<tr>
<td></td>
<td>(0.107)**</td>
<td>(0.0812)***</td>
<td>(0.101)***</td>
</tr>
<tr>
<td>Permanent income</td>
<td>0.790</td>
<td>0.899</td>
<td>1.019</td>
</tr>
<tr>
<td></td>
<td>(0.096)**</td>
<td>(0.087)**</td>
<td>(0.101)***</td>
</tr>
<tr>
<td>Unexplained income</td>
<td>0.912</td>
<td>0.917</td>
<td>0.916</td>
</tr>
<tr>
<td></td>
<td>(0.0162)**</td>
<td>(0.019)**</td>
<td>(0.022)**</td>
</tr>
<tr>
<td>Variance of income</td>
<td>3.88e-13</td>
<td>1.32e-12</td>
<td>5.75e-13</td>
</tr>
<tr>
<td></td>
<td>(1.65e-13)**</td>
<td>(5.27e-13)**</td>
<td>(2.34e-13)**</td>
</tr>
<tr>
<td>Head_illness</td>
<td>-2246.162</td>
<td>-2358.815</td>
<td>-4628.052</td>
</tr>
<tr>
<td></td>
<td>(6476.290)</td>
<td>(6504.451)</td>
<td>(6854.272)</td>
</tr>
<tr>
<td>Members 0_5</td>
<td>-6068.467</td>
<td>-5803.777</td>
<td>-6949.286</td>
</tr>
<tr>
<td></td>
<td>(3727.770)</td>
<td>(3964.023)</td>
<td>(4257.505)</td>
</tr>
<tr>
<td>Members 6_11</td>
<td>-9836.365</td>
<td>-11674.780</td>
<td>-12907.160</td>
</tr>
<tr>
<td></td>
<td>(3693.142)**</td>
<td>(3817.259)**</td>
<td>(4050.327)**</td>
</tr>
<tr>
<td>Members 12_17</td>
<td>-15746.600</td>
<td>-19759.990</td>
<td>-21366.370</td>
</tr>
<tr>
<td></td>
<td>(3703.723)**</td>
<td>(3733.735)**</td>
<td>(4294.037)**</td>
</tr>
<tr>
<td>Members 18_60</td>
<td>-19899.080</td>
<td>-22746.770</td>
<td>-25888.910</td>
</tr>
<tr>
<td></td>
<td>(3251.749)**</td>
<td>(3159.610)**</td>
<td>(3867.528)**</td>
</tr>
<tr>
<td>Members 61_up</td>
<td>-10642.960</td>
<td>-14640.300</td>
<td>-16111.050</td>
</tr>
<tr>
<td></td>
<td>(5117.994)**</td>
<td>(5154.851)**</td>
<td>(5767.064)**</td>
</tr>
<tr>
<td>Cons</td>
<td>-307.919</td>
<td>-1265.014</td>
<td>-839.410</td>
</tr>
<tr>
<td></td>
<td>(12179.730)</td>
<td>(11139.920)</td>
<td>(10652.050)</td>
</tr>
</tbody>
</table>

Number of observations: 5648 4903 4144
R-squared: 0.779 0.781 0.767
Sargent-Hansen test: 1.4e+11*** 5.0e+09*** 3.8e+10***
F-tests:
- Test 1 : 7.860** 5.080*** 0.270
- Test 2 : 0.790 0.950 0.470
- Test 3 : 3.2e+06*** 33076.970*** 94346.290***

**Notes:**
1.) Robust standard errors in brackets under coefficients
2.) * significant at 10%; ** significant at 5%; ***significant at 1%
3.) Test 1: coefficient of YT = 1, Test 2: coefficient YT = coefficient of YP and Test 3: village-year dummies jointly insignificant

The regression results show overwhelming evidence of the relationship between Thai agricultural household savings and transitory and permanent, together with unexplained income, in all groups of regions. The saving propensities out of transitory income are close to one and are statistically significant at the 1% level in all regions.
groups of regions\textsuperscript{88}. These results are highly consistent with the PIH, and as with some studies such as those of Paxson (1992: 15-33) and Kazia, and Ud (2006: 413-446). This implies that households heavily depend and their savings in smoothing their consumption when they face income shocks due to rainfall variation. The estimated propensities to save out of permanent and unexplained income are close to one and additionally have a significant impact at the 1\% level in all groups of regions. For the case of permanent income, nevertheless, this yielded the contradictory results with the PIH, in which the saving propensities out of permanent income should be close to zero. One of the rough explanations of this evidence is that it is the reverse of the consumption behavior exhibited in the previous study, and it is also a robust check for our present study. More specifically, under the identity of income, consumption and savings \((s \equiv y - c)\textsuperscript{89}\), finding a closing zero of the propensities to consume out of permanent income in our study, as well as the study of Carroll (1994: 111-147) and Zhou (2003: 192-212), implies that the saving propensities out of permanent income should be close to one instead.

To understand clearly why the propensities to save out of permanent income of Thai agricultural households are close to one, one should understand the theory of intertemporal choices with budget constraints, which explains how individuals or households choose to allocate consumption over the span of their lives. Under this theory, households try to maximize their lifetime utility by smoothing the path of consumption over their life cycle. Thus, when current income is less than the average lifetime income, households will use savings (or borrowings) to enjoy their current consumption\textsuperscript{90}, and then debt will be paid back in the future when the situation is

\textsuperscript{88} It should be noted that this is also the robust check in consumption model in our consumption model.

\textsuperscript{89} Give \(\Delta y = \Delta c + \Delta s\) and dividing all by \(\Delta y\) yield: \(I = \frac{\Delta c}{\Delta y} + \frac{\Delta s}{\Delta y}\), or \(I = MPC + MPS\).

\textsuperscript{90} For simplicity, from the consumption function (eq.19), if we substitute this equation into the identity of income, consumption and saving \(i.e. s_t=y_t-c_t\), we obtain:

\[ s_t = \left[ y_t - E \sum_{j=0}^{\infty} \frac{1}{1+r+j} y_{t+j} \right] - \left( \frac{\epsilon}{1+r} \right) \bar{A}_t \]

therefore, saving decisions depend on the difference between current income and permanent income.
reversed. The Thai economy during the period of our data survey highly might takes part in the evidence of a closing one of the propensities to save out of permanent income of households. Yunyong Thaichaloen; Kiatipong Ariyapruchya and Titima Chucherd (2004: 7-9) indicated that interest rates in the Thai economy, both nominal and real term, have been at a historic low over the past few years due to low inflation and excess liquidity in the bank sector. Consequently, it is very possible that a large number of households may have expected an increase in their future income due to the economic situations in Thailand at that time. Therefore, when their average lifetime income is higher than their current income, households may decide to enjoy their current consumption by using their savings (or borrowings) to finance it.

In accordance with “the saving for a rainy day” hypothesis (Campbell, 1987: 1249-1273), our results show a large positive, significant relationship between household savings and earning variability in all groups of regions. The coefficients of income variance range from 1.32e-12 to 5.75e-13 at a 1% level of significance. These results are thus consistent with the precautionary saving motive hypothesis and also consistent with several studies, such as those of Kazarosian, (1997: 241-247), Lusardi (1998: 449-453), Jalan and Ravillion (2001: 23-49), Guariglia (2001: 619-634), Kim and Guariglia (2004: 289-310), and Kazianga and Udry (2006: 413-446). Finding this precautionary saving motive behavior among Thai agricultural households implies that households are rational and forward-looking, and hold a buffer stock of savings that serves to shield their consumption against future income uncertainty (Carroll, 1994: 142).

We find that all significant family composition variables have a negative impact on household savings in all groups of regions. This shows a somewhat consistent pattern between saving and the age structure of the household members, as with the consumption model. However, most of our results are still consistent with the study of Paxson (1992: 15-33), which found that most Thai household members whose age was over 12 were negatively significant. More specifically, Paxson found only household members whose age was 12 to 17 and whose age was over 65 were significant, and found that household members whose age was over 65 depressed saving more than other age categories even though she claimed that the coefficients were imprecisely estimated. Similarly to the study of Paxson, our study finds not only
the significance of both household members whose age is 12 to 17 year and whose age is over 60 years, but also household members whose age is 18-60 years. The household members that are nevertheless the most saving depressers in our study are household members whose age is 18 to 60, age 12 to 17, and age over 60 years respectively. This clearly contradicts the case of household members whose age is 18 to 60 years, who should be the least saving depressers. One of the plausible explanations for this evidence is the boom in consumption in Thailand as a result of demand factor, such as low interest rates, low inflation rates and increased income and employment confidence, as well as supply factor, such as shifting in commercial bank strategies toward personal lending and intensive competition by nonbanks during the period of this study (Kobsak Pootrakul et al., 2005: 9 and Thitima Chucherd, 2006: 8-9). This economic environment may encourage a large number of people, especially those that are workers and receive their own income, to enjoy consumption today. In addition, Kobsak Pootrakool et al., (2005: 1-61) indicated that household savings in Thailand decline in all age groups as a result of a rise in the consumption mean, while he revealed that there were also saving constraints91 among Thai households, especially those with low income and low education. Therefore, it is very possible that a large decrease in the savings of household members whose age is 18 to 60 years in our study is caused by these economic environments.

When we look at the response of household savings to idiosyncratic and aggregate shocks, we find no evidence for the impact of idiosyncratic shock, which is proxied by the illness of the household head on household savings in all groups of regions, while aggregate shocks which are represented by village (tambon)- year dummies appear to be very important in explaining household saving decision in all groups of regions due to the 1% level of significance of these variables (the F-statistic range from 3.2e+06 to 94346.29).

To examine more specifically the use of savings as a consumption smoothing mechanisms by Thai agricultural households, we regress separately the saving equation for households in each region with fixed effect as a result of a significance at the 1% level of the Sargent-Hansen test and thus table 5.2 shows the fixed effect

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91 Households face a saving constraint if a respondent reports at least one unmet need for a saving service (Pootrakool et al, 2005: 28).
Table 5.2 Fixed Effect Saving Regressions (each region):

<table>
<thead>
<tr>
<th>Regions</th>
<th>Northern</th>
<th>Southern</th>
<th>Northeastern</th>
<th>Central, Eastern and Western</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variables</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transitory income</td>
<td>1.158</td>
<td>1.197</td>
<td>0.857</td>
<td>0.777</td>
</tr>
<tr>
<td>(0.159)***</td>
<td>(0.198)***</td>
<td>(0.095)***</td>
<td></td>
<td>(0.095)***</td>
</tr>
<tr>
<td>Permanent income</td>
<td>1.013</td>
<td>0.919</td>
<td>1.034</td>
<td>0.867</td>
</tr>
<tr>
<td>(0.101)***</td>
<td>(0.144)***</td>
<td>(0.127)***</td>
<td></td>
<td>(0.104)***</td>
</tr>
<tr>
<td>Unexplained income</td>
<td>0.916</td>
<td>0.911</td>
<td>0.913</td>
<td>0.941</td>
</tr>
<tr>
<td>(0.018)***</td>
<td>(0.031)***</td>
<td>(0.036)***</td>
<td></td>
<td>(0.030)***</td>
</tr>
<tr>
<td>Variance of income</td>
<td>6.92e-09</td>
<td>-3.75e-07</td>
<td>3.30e-08</td>
<td>8.61e-06</td>
</tr>
<tr>
<td>(2.96e-09)***</td>
<td>(3.37e-07)</td>
<td>(1.71e-08)</td>
<td></td>
<td>(8.21e-06)</td>
</tr>
<tr>
<td>Head_illness</td>
<td>-4821.153</td>
<td>6653.658</td>
<td>-7954.240</td>
<td>31784.830</td>
</tr>
<tr>
<td>(12565.910)</td>
<td>(23614.620)</td>
<td>(8470.408)</td>
<td></td>
<td>(19313.990)</td>
</tr>
<tr>
<td>Members 0_5</td>
<td>-10645.130</td>
<td>-9169.077</td>
<td>-6150.782</td>
<td>3110.241</td>
</tr>
<tr>
<td>(8851.143)**</td>
<td>(13703.410)</td>
<td>(4411.640)</td>
<td></td>
<td>(11073.100)</td>
</tr>
<tr>
<td>Members 6_11</td>
<td>-16954.530</td>
<td>-4349.397</td>
<td>-11859.760</td>
<td>-6075.694</td>
</tr>
<tr>
<td>(8851.143)**</td>
<td>(13703.410)</td>
<td>(4411.640)</td>
<td></td>
<td>(11073.100)</td>
</tr>
<tr>
<td>Members 12_17</td>
<td>-25453.710</td>
<td>-613.988</td>
<td>-20359.040</td>
<td>-23843.750</td>
</tr>
<tr>
<td>(9516.504)***</td>
<td>(11657.490)</td>
<td>(4678.985)</td>
<td></td>
<td>(7594.889)</td>
</tr>
<tr>
<td>Members 18_60</td>
<td>-26259.730</td>
<td>-22851.340</td>
<td>-25820.180</td>
<td>-17905.540</td>
</tr>
<tr>
<td>(5494.277)***</td>
<td>(9866.534)</td>
<td>(4552.353)</td>
<td></td>
<td>(5377.766)</td>
</tr>
<tr>
<td>Members 61_up</td>
<td>-28078.360</td>
<td>-6348.846</td>
<td>-11706.190</td>
<td>-19598.520</td>
</tr>
<tr>
<td>(8395.440)***</td>
<td>(16475.830)</td>
<td>(7282.941)</td>
<td></td>
<td>(11280.900)</td>
</tr>
<tr>
<td>Cons</td>
<td>-13673.490</td>
<td>155489.600</td>
<td>9119.844</td>
<td>-76083.210</td>
</tr>
<tr>
<td>(18100.630)</td>
<td>(148288.600)</td>
<td>(12255.580)</td>
<td></td>
<td>(38940.440)</td>
</tr>
</tbody>
</table>

| Number of observations   | 1325     | 745      | 2819        | 759                         |
| R-squared                | 0.785    | 0.533    | 0.694       | 0.801                       |
| Sargent-Hansen test      | 2.1e+06***| 4.2e+04***| 6.4e+05***  | 3.5e+04***                  |
| F-tests :                |          |          |              |                             |
| Test 1 :                 | 0.980    | 0.990    | 2.270        | 5.520***                    |
| Test 2 :                 | 0.520    | 1.390    | 1.590        | 0.470                       |
| Test 3 :                 | 509.420***| 162.400***| 759.740***  | 59.510***                   |

Notes: 1.) Robust standard errors in brackets under coefficients
       2.) * significant at 10%; ** significant at 5%; ***significant at 1%
       3.) Test 1: coefficient of YT = 1, Test 2: coefficient YT = coefficient of YP and Test 3: village-year dummies jointly insignificant

saving regression for each region. The regression on saving provides evidence of a statistically-significant relationship at the 1% level between household savings and transitory, and permanent and unexplained income respectively in every region. Consistent with the PIH, the estimated propensity to savings out of transitory income closes to one in every region, especially in the Northern and Southern regions, where
their saving propensities out of transitory income are higher than one. This implies that the households in those two regions heavily depend on their savings to smooth their consumption in the face of income shocks due to rainfall variation. On the other hand, households in the group of Central, Eastern and Western regions have the saving propensities out of transitory income at about 0.777, and thus they depend on their savings for consumption smoothing less than other regions. With this result, it should be noted that being a region where the households depend on saving for consumption smoothing less than other regions of the Central, East and West group might be consistent with being only one region where transitory income affects household consumption in our previous essay. Similar to transitory income, the propensity to savings out of permanent income is also close to one in every region. This evidence nevertheless contradicts the PIH. The explanation for this result has already been discussed in the case of groups of regions.

In most regions, household behavior appears to be consistent with buffer stock models, which implies that if there is higher future income variability, there are higher savings. The coefficients of variance income are positively significant at the 1% and 5% level, with a magnitude at around 6.92e-09 and 3.30e-08 in the Northern and Northeastern regions respectively. This implies that the Northern region is where households use the most savings as buffer stocks to protect their consumption against the possibility of future income shock, while the households in the Northeastern region appear to use savings as a buffer stock less frequently. Meanwhile, this precautionary saving motive does not appear in Southern and the group of Central, Eastern and Western regions. A plausible explanation for this evidence may be a result of the difference in financial development and financial access, including income per capita among regions. From the data of the Bank of Thailand in 2007, excluding Bangkok, the Central region exhibited the most financial development, followed by the Southern region, while a level of financial development close to this was found for the Northern and Northeastern regions. The Central region has the highest proportion of deposits per population with a proportion of around 0.061, followed by the Southern, Northern, and Northeastern regions with a proportion of around 0.045, 0.017 and 0.015 respectively. Similarly, the highest proportion of deposits per Gross Regional Product (GRP) is also found in the Central region with a
proportion of around 2.437, while the Southern, Northern, and Northeastern regions have proportion of around 1.062, 0.583, and 0.792 respectively. In addition, the Central region also has a smaller proportion of the population per commercial bank branch than the other regions; that is, while the Northeastern, Northern and Southern regions have this proportion around 45,177.398, 26,382.07 and 21,745.806 respectively, while the Central region has this proportion at only around 14,428.452.

These data indicate that the Central and Southern regions are much higher in financial development (or even household wealth) than the Northern and Northeastern regions. This implies that households in the Central and Southern regions tend to face liquidity constraints less than those in the Northern and Northeastern regions92, and thus the households in the Central and Southern regions tend to exhibit the precautionary saving motive less. This explanation is supported by a study of Lee and Sawada (2010: 77-86) who examined precautionary savings under liquidity constraints, and found that the poor and liquidity-constrained households behaved prudently, while the rich and unconstrained ones did not exhibit precautionary saving motives. As a matter of fact, economists have been aware that liquidity constraints can strictly increase precautionary savings under very general circumstances, at least since Zeldes 1981 (Carroll and Kimball, 2001: 3), even for consumers with quadratic utility functions which provide no inherent precautionary saving motives. This idea is nonetheless more recognized through the proof of several economists. These include Zeldes (1989 (b): 305-346), Kimball (1990: 53-73), Corugedo (2002: 1-38), and Carroll and Kimball (2001: 1-57).

As with a group of region analysis, most family composition variables affect household savings in most regions. However, these results yield mixed results following the LCH. Household saving behavior still shows clear contradictions with the LCH in the Northeastern and Southern regions because household members whose age is 18 to 60 still are the most saving depressers in these two regions. On the other hand, these household members turn out to be the least saving depressers in the group of Central, Eastern and Western regions; mean-while, household members whose age is over 60 are the most saving depressers in the Northern region. This

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92 Karaivanov (2012: 210) used data from the Townsend Thai Survey and found that the Northeast region face much stronger financial constraint than the central region.
indicates that even if a large number of Thai agricultural households behave in a contradictory fashion in relation with to the LCH, several households follow the LCH, especially households in the group of Central, Eastern and Western regions as well as the Northern regions.

We still find no impact of idiosyncratic shock proxied by household head illness on household savings in any region. This implies that none of the households in any region favors using savings as a consumption smoothing mechanism when they face this kind of shock. Unlike the idiosyncratic shock, the regression results show a statistically-significant relationship at the 1% level between household savings and aggregate shocks proxied by village (tambon)-year dummies in every regions (the F-statistic range from 59.51 to 759.74).

5.4.2 Borrowing Equation Estimation

As with the saving equation estimation, borrowings are examined by dividing them into groups of regions and for each region. The random effects Tobit borrowing regressions for groups of regions are presented in table 5.3

Log likelihood value, which presents the precision of the model shows that the model of the group of Northern and Northeastern regions is better than that of the group of all regions, except the Southern region, and the group of all regions. Unlike the saving equation, the regression on borrowings provides different evidence of the statistically significant impact of transitory, permanent, and unexplained income on household borrowings. Even though unexplained income is significant in all groups of regions, the transitory income coefficient is positive significant at the 1% level with a small magnitude only in the group of all regions. This implies that, overall, some Thai agricultural households still depend on borrowings in smoothing their consumption in the face of income shocks due to rainfall variation. This result is also supported by several studies, for instance, that of Kochar (1995: 159-164), Fafchamps and Lund (2003: 261-287), Skoufias (2003: 67-91), Howe (2003: 1-53), and Beegle, Dehejja and Gatti (2006: 80-96).

Similar to transitory income, the coefficient of permanent income is positively significant at the 5% level only for the group of Northern and Northeastern regions. However, it should be noted that the magnitude of these coefficients is bigger than all
**Table 5.3** Random Effects Tobit Borrowing Regressions (group of region):

<table>
<thead>
<tr>
<th>Regions</th>
<th>All regions</th>
<th>All regions except southern region</th>
<th>Northern and Northeastern regions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variables</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transitory income</td>
<td>0.193 (0.058)**</td>
<td>0.008 (0.111)</td>
<td>0.076 (0.125)</td>
</tr>
<tr>
<td>Permanent income</td>
<td>0.165 (0.210)</td>
<td>0.059 (0.175)</td>
<td>0.335 (0.184)**</td>
</tr>
<tr>
<td>Unexplained income</td>
<td>0.170 (0.018)**</td>
<td>0.173 (0.018)**</td>
<td>0.175 (0.021)**</td>
</tr>
<tr>
<td>Variance of income</td>
<td>2.47e-14 (6.43e-14)**</td>
<td>7.94e-14 (2.11e-13)</td>
<td>3.01e-14 (9.64e-14)***</td>
</tr>
<tr>
<td>Head_illness</td>
<td>-37956.310 (20614.490)**</td>
<td>-24988.540 (18415.510)</td>
<td>-23709.210 (19405.010)</td>
</tr>
<tr>
<td>Members 0_5</td>
<td>-1522.442 (5422.940)</td>
<td>-2156.451 (4884.233)</td>
<td>563.701 (5144.410)</td>
</tr>
<tr>
<td>Members 6_11</td>
<td>6336.302 (4589.723)***</td>
<td>7184.206 (4150.267)**</td>
<td>3709.836 (4339.149)</td>
</tr>
<tr>
<td>Members 12_17</td>
<td>19241.790 (5199.951)**</td>
<td>16189.060 (4621.586)**</td>
<td>14568.650 (4933.923)***</td>
</tr>
<tr>
<td>Members 18_60</td>
<td>15365.760 (6273.854)***</td>
<td>15310.300 (5411.858)***</td>
<td>9020.933 (5504.060)***</td>
</tr>
<tr>
<td>Members 61_up</td>
<td>-12720.540 (6646.179)***</td>
<td>-6542.235 (6612.302)</td>
<td>-12627.920 (6093.343)***</td>
</tr>
<tr>
<td>Cons</td>
<td>1067.180 (78923.180)</td>
<td>15699.420 (67036.600)</td>
<td>4144 (22152.370)**</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of observations</th>
<th>5648</th>
<th>4903</th>
<th>4144</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of censored observations</td>
<td>2231</td>
<td>1738</td>
<td>1389</td>
</tr>
<tr>
<td>Log likelihood</td>
<td>-47423.418</td>
<td>-43309.728</td>
<td>-37651.127</td>
</tr>
<tr>
<td>Test of village (province)-year dummies insignificant</td>
<td>452.730***</td>
<td>429.320***</td>
<td>316.430***</td>
</tr>
</tbody>
</table>

**Notes:**
1.) Standard errors in brackets under coefficients
2.) * significant at 10%; ** significant at 5%; *** significant at 1%

Significant income variables. To explain why household borrowings depend on permanent income, we can still explain this through the intertemporal choice theory, as was explained in saving equation \(^93\). This theory, together with the household budget

\(^93\) The intertemporal choice theory, in its simple form, is the marginal rate of substitution equals the relative price of consumption and saving, which lies at the heart of much of the recent work on consumption, on savings, and asset pricing (Deaton, 1992: 25).
constraints, tells us how the consumption levels of an optimizing household will evolve over the life cycle. Thus, in periods when average lifetime income is high relative to current income as a result of such as a decrease in interest rate, a decrease in inflation rate, etc., households will borrow to serve their current consumption needs. The situation of the Thai economy in the period of our data survey is very consistent with this explanation. A decrease in both interest rate and inflation rate during that period may encourage a large number of households to expect an increase in expected future income\(^{94}\), and thus encourage households to borrow to finance their current consumption. Yunyong Thaichaloen et al, 2004: 6) indicated that a rise in household debt depends on three main demand-side factors; that is, (1) changes in demographic structure, (2) the expectation of future income path, and (3) the expectation of a future interest rate path. They concluded that most of these factors were the main cause in the rise in Thai household debt. Furthermore, a study of Park and Rodrigues (2000: 301-320) which examined directly the consistency of consumer borrowings with the PIH in which growth in consumer credit should be related to the consumers’ expectations of future income growth, disclosed that consumer borrowings increase with the estimate of permanent income\(^{95}\).

No evidence is found for the relationship between income variance and household borrowings in any group of regions. This implies that Thai agricultural households do not hold a buffer stock in terms of borrowing to shield their consumption in the face of future income uncertainty. However, this result is perhaps not beyond what could be expected. Using borrowing as a buffer stock creates a high cost when we compare it with other mechanisms, especially savings. Many households might not choose this approach even though they are poor and without savings. Alternatively, they may implement grain stocks, livestock, an increase in

\(^{94}\) Actually, a decrease in interest rate contributes three effects that is the substitution effect, the income effect and future income effect (Deaton, 1992: 3).

\(^{95}\) Slightly adapting the relationship between savings, current income and permanent income by including borrowings rather than savings yield:

\[
B_t = \left[ y_t - E \sum_{j=0}^{\infty} \frac{1}{(1+r)^{t+j}} y_{t+j} \right] - \left( \frac{1}{1+r} \right) A_t .
\]

This equation show that if permanent income is higher than current income, households will borrow more, but vice versa if permanent income is less than current income.
work hours, or even temporary out migration of family labor and not sending their children to school, as studied by Jalan and Ravallion (2001: 23-49), to serve as a buffer stock against future income shock.

There is clearly a consistent relationship between the impact of the family composition variables on consumption, savings and borrowings of households. Most household numbers whose age is over 5 variables show a highly significant impact on these mechanisms. For borrowings, nevertheless, one should note that there is a difference in the borrowing behavior among these households. While household members whose age is 12 to 17 and 18 to 60 have a positive, significant impact on household borrowings in all groups of regions, household members whose age is over 60 shows the opposite. This indicates that household members whose age is 12 to 60 may be the main cause of household debt. In addition, this evidence is also consistent with the consumption and saving behavior of the households in our previous section. In our previous section, besides being households that most consume relatively, household members whose age is 12 to 60 are also the most saving depressers. Thus, it is not surprising if these household members are those that most borrow among other age structures of household members. Nevertheless, we may not be much concerned about the borrowing behavior of household members whose age is 12 to 17 since this is still consistent with the LCH, where a young household should dissave and borrow against future income to serve their desired consumption level. On the other hand, we concern in being the large borrower of household members whose age is 18 to 60. This clearly contradicts the LCH, in which they should save more than other household members, and then should borrow less than other household members. Despite appearing to the contradict the LCH of the household members in this study, this evidence is consistent with a study of Yunyong et al. (2004: 6), which indicated that there is an increase in indebtedness across all age groups in particular the middle-age groups (whose age is around 30 to 60) due to Thailand’s low interest rate and inflation rate, including income growth during the same period as seen in our data survey.

Consistent with consumption and saving behavior, household members whose age is over 60 have a negative relationship with household borrowings. In the consumption equation, these household members consume least relatively, while the
least saving depressers are among saving equation. This implies that these household members may be quite thrifty and try to save more to be a bequest motive for their offspring. Thus, it is not surprising if these household members cause no household debt. This evidence is also compatible with that found in Yunyong Thaichaloen et al.’s (2004: 6) study, in which they exhibited a gradual decline in Thai household debt to household income for household members whose age is over 50, and present a low level of debt for household members whose age is over 60.

Although we also find an indication of the impact of illness of the household head, which represents the idiosyncratic shock on household borrowings, the sign is negative. Nevertheless, for the aggregate shock, our results still show a statistically significant relationship at the 1% level between household borrowings and village (provinces) dummies which stand for an aggregate shocks in all groups of regions (the F-statistic range from 316.430 to 452.730). This indicates that borrowings are not implemented to shield shocks due to the household head’s illness; rather, households borrow in the face of common shocks.

Table 5.4 reports the random effect Tobit borrowing regression for each region. The log likelihood value is quite different among the four regions. In addition, the impact of the explanatory variable on Thai agricultural household borrowings is also diverse among the four regions. Although the regression on household borrowings provide evidence of a statistically significant relationship between unexplained income on household borrowings in every region, household borrowings respond negatively to transitory income shocks due to rainfall variation only for the group of the Central, Eastern and Western regions. These imply that most households in every region do not implement borrowing mechanisms in smoothing their consumption.

Unlike the impact of transitory income, the response of household borrowings to permanent income is quite clear in most regions. Permanent income has a positive significant impact on household borrowing at the 1% level in the Northern, Southern regions and the group of Central, Eastern and Western regions. Only the Northeastern region is found to have no significance of permanent income. This indicates that only households in the Northern, Southern and the group of the Central, Eastern and Western regions, respond to change in their permanent income, while this reaction
Table 5.4 Random Effects Tobit Borrowing Regressions (each region):

<table>
<thead>
<tr>
<th>Variables</th>
<th>Northern</th>
<th>Southern</th>
<th>Northeastern</th>
<th>Central, Eastern and Western</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transitory income</td>
<td>-0.268</td>
<td>0.127</td>
<td>0.064</td>
<td>-0.541</td>
</tr>
<tr>
<td></td>
<td>(0.447)</td>
<td>(0.096)</td>
<td>(0.096)</td>
<td>(0.203)**</td>
</tr>
<tr>
<td>Permanent income</td>
<td>0.679</td>
<td>1.476</td>
<td>-0.027</td>
<td>0.178</td>
</tr>
<tr>
<td></td>
<td>(0.164)**</td>
<td>(0.489)**</td>
<td>(0.102)</td>
<td>(0.068)**</td>
</tr>
<tr>
<td>Unexplained income</td>
<td>0.169</td>
<td>0.143</td>
<td>0.170</td>
<td>0.157</td>
</tr>
<tr>
<td></td>
<td>(0.041)**</td>
<td>(0.082)**</td>
<td>(0.023)**</td>
<td>(0.039)**</td>
</tr>
<tr>
<td>Variance of income</td>
<td>2.53e-09</td>
<td>-2.08e-08</td>
<td>-9.56e-09</td>
<td>-2.24e-06</td>
</tr>
<tr>
<td></td>
<td>(2.44e-09)</td>
<td>(1.19e-07)</td>
<td>(1.99e-08)</td>
<td>(9.04e-06)</td>
</tr>
<tr>
<td>Head_illness</td>
<td>-49206.220</td>
<td>-225542.400</td>
<td>-4367.854</td>
<td>-53125.490</td>
</tr>
<tr>
<td></td>
<td>(44784.440)</td>
<td>(172939.300)</td>
<td>(18898.860)</td>
<td>(57026.290)</td>
</tr>
<tr>
<td>Members 0_5</td>
<td>15635.880</td>
<td>39933.240</td>
<td>-3869.651</td>
<td>-17789.040</td>
</tr>
<tr>
<td></td>
<td>(14596.910)</td>
<td>(37934.740)</td>
<td>(4641.271)</td>
<td>(15319.000)</td>
</tr>
<tr>
<td>Members 6_11</td>
<td>9262.195</td>
<td>20052.320</td>
<td>1527.081</td>
<td>23908.460</td>
</tr>
<tr>
<td></td>
<td>(12388.770)</td>
<td>(28785.270)</td>
<td>(3918.775)</td>
<td>(12171.740)**</td>
</tr>
<tr>
<td>Members 12_17</td>
<td>26942.470</td>
<td>26036.660</td>
<td>12184.820</td>
<td>7218.495</td>
</tr>
<tr>
<td></td>
<td>(12249.550)**</td>
<td>(272240.190)</td>
<td>(4301.470)**</td>
<td>(13253.720)***</td>
</tr>
<tr>
<td>Members 18_60</td>
<td>6048.454</td>
<td>36855.220</td>
<td>18136.740</td>
<td>6333.374</td>
</tr>
<tr>
<td></td>
<td>(7476.179)</td>
<td>(18002.960)**</td>
<td>(4101.059)**</td>
<td>(7252.877)</td>
</tr>
<tr>
<td>Members 61_up</td>
<td>-8871.630</td>
<td>-24810.340</td>
<td>4149.755</td>
<td>-12432.060</td>
</tr>
<tr>
<td></td>
<td>(10789.030)</td>
<td>(27200.110)</td>
<td>(6610.480)</td>
<td>(11783.010)</td>
</tr>
<tr>
<td>Cons</td>
<td>-224349.200</td>
<td>-823045.200</td>
<td>-15106.590</td>
<td>20609.650</td>
</tr>
<tr>
<td></td>
<td>(44612.390)**</td>
<td>(244981.800)**</td>
<td>(16861.760)</td>
<td>(71552.640)</td>
</tr>
</tbody>
</table>

|                           | 1325     | 745      | 2819        | 759                        |
| Number of observations    | 450      | 494      | 939         | 349                       |
| Number of censored        | -12192.318| -3238.537| -25278.663  | -5647.286                 |
| observations             | 131.070***| 26.900   | 141.890***  | 108.830***                |
| Log likelihood            |          |          |            |                           |
| Test of village           |          |          |            |                           |
| (provinces)-year          |          |          |            |                           |
| dummies insignificant     |          |          |            |                           |

Notes: 1.) Standard errors in brackets under coefficients
2.) * significant at 10% ; ** significant at 5% ; ***significant at 1%

was not apparent for the households only in the Northeastern region. As explained in the preceding results, permanent income can influence borrowings as a result of attempting to maximize a household’s lifetime utility by smoothing the consumption path over their life cycle. If there is thus a difference between current income and permanent income, households can smooth their consumption by borrowings.
Thailand’s economic factors during the period of the data survey, such as a lower interest rate, lower inflation improved confidence in income and job prospects, and intensive competition between banks and non-banks (Yunyong Thaichaloen et al., 2004: 7-9), highly contributed to the anticipation of an increase in the expected future income of households. Thus, this leads to anticipation of the difference between current income and permanent income for many households, and then caves them to borrow to smooth their consumption. Borrowings depend notwithstanding not only on the household’s decision but also on the number of financial intermediations which are willing to loan.

In the case of the Northeastern region, it can hardly be rejected that this region has a low level of financial development. For a large number of households, especially those that are the poor and small farmers, it is difficult to access any financial services. Thus, even if there are many economic factors that encourage them to enjoy with their current consumption, there may be a few financial institutions willing to loan to them. Consequently, changes in the expected permanent income do not lead to change in their consumption.

As explained for the analysis of the group of region that it is difficult for most households to use borrowings as a buffer stock due to their high cost, consequently, we also find no evidence for a relation between income variance and household borrowings for any region. This reaffirms that most Thai agricultural households do not hold a buffer stock in terms of borrowings to shield their consumption in the face of future income uncertainty.

The relationship between family composition and household borrowings is different for each region even if most significant variables are household members whose age is over 5 for every region. There are two groups of regions which either follow the LCH or reject the LCH. Household borrowings are consistent with the LCH in the case of households in the Northern and the group of Central, Eastern, and Western regions. Household members whose age is 12 to 17 and whose age is 6 to 11 are the most borrowers in the Northern region and the group of the Central, Eastern and Western regions respectively. This is consistent with the LCH because these household members are young members and they should dissave as well as borrow to serve their desired consumption level. On the other hand, the households that borrow
the most are found in the Southern and Northeastern regions, where the household members whose aged is 18 to 60. This clearly contradicts the LCH. Nevertheless, it should be noted that there is a consistency between the consumption, saving, and borrowing behavior of the two groups: while the consumption, saving and borrowing behavior of households in the Northern region and the group of the Central, Eastern, and Western regions is quite consistent with the LCH, the consumption, saving and borrowing behavior of the households in the Southern and Northeastern regions contradict the LCH.

There is still no evidence for a significant relationship between illness of household head and household borrowings in any region, while a statistically significant relationship is found at the 1% level between village (provinces) - year dummies and household borrowings in all regions except the Southern region (the F-statistic ranges from 26.90 to 141.89). This implies that besides the use of savings, most households in every region also use borrowings to smooth their consumption only when they face aggregate shocks but this is the opposite for both income shocks and idiosyncratic shock.

5.5 Conclusion

Similar to the agricultural households in most developing countries, the income of Thai agricultural household is highly uncertain as a result of either idiosyncratic or aggregate shocks. These shocks, such as weather variation, the incidence of decease, pest attack, price volatility, as well as illness and the unemployment of household members, can leave some households under a minimal standard of living, which is an acute threat to the household’s subsistence. The permanent income hypothesis predicts nevertheless that if credit and insurance markets are complete, or if there exists alternative mechanisms for dealing with risk, these adverse shocks are not expected to affect household consumption. This paper examines the use of consumption smoothing mechanisms of Thai agricultural households through two main mechanisms; that is, savings and borrowings, since these are expected to be primary mechanisms which most households should initially regard.
Regressing through the three waves of Thai household panel data, we find that, on the average, Thai agricultural households heavily depend on their saving mechanism in smoothing their consumption, while there is a little evidence for using borrowings. However, when we examine each region separately, we find that only savings are highly implemented for households in every region, while borrowings are implemented for households only in some groups of regions; however, we find no use of borrowings as a consumption smoothing mechanisms for any region.

There is a difference in the impact of transitory income shock due to rainfall variation on savings and borrowings in each region. The regression shows that only savings has a significant relationship with transitory income in every region. A significant response of borrowings to transitory income is not finds in any region. Accordingly with transitory income, household savings appear still to have a significant relationship with permanent income in every region, while only the households in the Northeastern region do not respond to change in permanent income by increasing their borrowings. On the contrary, the results show that savings has a significant relationship with variance of income for only in the Northern and Northeastern regions whereas no households in any region respond to future income uncertainty by borrowings.

Unlike the impact of any type of income, family compositions have an identically impact on savings and borrowings. Most of the variables of household members whose age is over 11 are significant for every mechanism and in every region. We find that no households in any region use their savings, or borrowings to smooth their consumption due to the idiosyncratic shock proxied by illness of household head. On the contrary with the idiosyncratic shock, the regression results show overwhelmingly a significant relationship between aggregate shocks proxied by village-year dummy variables with savings, and borrowings in every region except for borrowings in the Southern region.
CHAPTER 6

EXTENSION II: RISK SHARING MODEL

6.1 Introduction

Risks are an inevitable fact of life for people in developing countries. In Thailand, a large number of households, mainly agricultural households, often face various risks as in other developing countries. Consequently, their lives are vulnerable to risks. However, even with the absence in a complete credit and insurance markets as a result of the well-known problem of asymmetric information (Stiglitz and Weiss, 1981: 393-410), Thai agricultural households have used a variety of alternative mechanisms to protect themselves from adverse risks in a way similar to the mechanisms in other developing countries.

Alderman and Paxson (1992: 1-2) have categorized alternative mechanisms into two main mechanisms. First are risk managements, which include crop and field diversification, income source diversification, sharecropper tenancy and migration of family member. Second are risk copings, which can be classified as those that smooth consumption intertemporally, through borrowings, selling assets, savings, and remittances, and smooth consumption across space (households) through risk sharing.

In addition to these two mechanisms, for most developing countries which might face both the incompleteness of formal insurance and the limitations of informal insurance mechanisms, the government in those countries may also take action in terms of public safety net programs such as crop and unemployment insurance and microcredit programs as another mechanism to improve people’s welfare.

Among the variety of mechanisms, apart from using consumption smoothing over time through savings and borrowings as shown in the first extension part, this

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96 Vulnerability is the likelihood that at a given time in the future, an individual will have a level of welfare below some norm or benchmark (Hoddinott and Quisumbing, 2003: 9).
97 See the detail of Thai rural credit system in Ammar Siamwalla et al. (1990: 271-295) and Kabaski and Townsend (2005)
study also examines consumption smoothing across households through risk sharing for six reasons. First, the credit and insurance markets in Thailand are still incomplete, especially in rural areas (see details in Ammar Siamwalla et al., 1990: 271-295 and Kabaski and Townsend, 2005). Second, consumption smoothing (over time) may be very costly in circumstances characterized by difficulty in borrowing (Kinsey, Burger and Gunning, 1998: 90). Third, most risk managements (ex-ante action) might be costly, so that the households would be sacrificing income, on average, in order to assume a less risky stream of income (Bardham and Udry, 1999: 95). Fourth, public safety nets are very costly and may crowd out other informal mechanisms (Cox and Jimenez, 1995: 321-334; Jensen, 2003: 89-112). Fifth, some households are too poor and weak to use both risk management mechanism and consumption smoothing over time strategies. Finally, with the acceptance in James Scott’s The Moral Economy of the Peasant in 1976, together with the well-known aspects of the Thai culture such as generosity and charitableness, especially in rural society, it is interesting to examine these abstracts through risk sharing behavior, in particular when the Thai economy became more industrialized as noted by Ravallion and Dearden (1988: 36) that as developing economics become more urbanized, that is a decline in a decline in the distributional significance of the moral economy.

Risk sharing is the diffusion in the effects of adverse shocks across households at any one point in time through formal institutions (such as insurance and future markets, and forward contracts for harvests) and informal mechanisms (including state-contingent transfer and remittances between friends and neighbors) (Alderman and Paxson, 1992: 2). If risks are fully pooled, the household’s own income should then not affect consumption patterns, and all idiosyncratic risks should be eliminated. In other words, the household consumption should co-move only with total community income which implies the Pareto efficient allocation of risk within the community holds in this case.

Excluding the original study of Mace (1991: 928-956) and Cochrane (1991: 957-976), which used U.S. data, most studies test the full insurance model by using data from developing countries. These include Townsend (1994: 539-591), Rovallion and Chaudhuri (1997: 171-184), and Morduch (2002: 1-19) for India; Jalan and Ravallion (1999: 61 – 81) for China; Gertler and Gruber (2002: 51-70) for Indonesia;
Fafchamps and Lund (2003: 261-287) for the Philippines; Weerdt and Dercon (2006: 337-356) for Tanzania, etc. Despite the variety in methodology and data sources, nonetheless, full insurance was rejected in these studies. This includes the study of Townsend (1995: 83-102), which used Thailand data also.

However, even though a fully Pareto-efficient allocation of risk within communities is rarely achieved (Bardhan and Udry, 1999: 100), it is still possible that partial risk sharing is an important method of consumption smoothing (Alderman and Paxson, 1992: 32). The existence of some level of risk sharing in at least implies that idiosyncratic risks are shared at some level among community members.

Motivated by the existence of partial risk sharing in at least, therefore, the objective of this second extension is to examine the evidence of risk sharing in Thai agricultural households. In addition, this study also reexamines Townsend’s study in Thailand (Townsend, 1995: 83-102) with a stronger technique and more insight. This study therefore is different from Townsend’s in several specifications. First, this paper uses three-wave Thai household panel data which cover the years 2005-2007, and thus allows for a look at the behavior of households over time as well as control for unobserved household heterogeneity. Second, instead of using the amphoe unit as an observation unit, this study uses the household unit as with most risk sharing studies. Third, as is earlier noted in the prospect of the existence of the moral economy, including the well-known Thai culture, this paper specifies Thai agricultural households which mostly dwell in rural areas and thus they are expected to have the most possibility of risk sharing behavior (Ravallion and Dearden, 1988: 36-44). Fourth, since a perfect risk sharing or full consumption insurance can hardly be found, we also test for partial consumption insurance within the same community. Fifth, because the general risk sharing model provides little information about how risk is actually shared (Fafchamp and Lund, 2003: 265), this study also provides this information by testing risk sharing through a risk sharing instrument. Finally, given the concern for the problem of endogeneity and measurement errors in income variables, we apply the instrument variable technique throughout the test.

The next section outlines the theoretical framework of modeling consumption across space. Section 6.2 describes the theoretical framework and provides a literature
review. Section 6.3 presents the empirical specifications, and section 6.4 discusses the empirical results. In section 6.5 the conclusion is set forth.

6.2 Theoretical Framework and Literature Review

With the incompleteness of credit and insurance markets, the high cost of consumption smoothing over time, risk management strategies and public safety net programs, some households that are poor and weak may be limited in utilizing these mechanisms, which mostly depend on either themselves or private and public institutions in mitigating an unanticipated adverse shock. However, there is a possibility that there may be community mechanisms in some communities to allocate risk efficiently, as presented in Scott’s The Moral Economy of the Peasant in 1976. Specifically, households within a village, kinship, and other social networks may share each other’s risk through institutional arrangements, which approximate the Pareto-efficient allocation of risk (Bardhan and Udry, 1999: 95), and thus a household’s risk is fully shared in this case.

In a Pareto-efficient allocation of risk within the community, households face only aggregate risks. Idiosyncratic income shocks are completely insured within the community. Diamond (1967: 759-776) and Wilson (1968: 119-132) have presented a primary derivation in the basic proposition, that if preferences are time-separable and display weak risk aversion, if all individuals discount the future at the same rate, and if all information is held in common, then optimal allocation of risk bearing of a single good in a stochastic environment implies that all individual consumptions are determined by aggregate consumption, no matter what the date and history of the shocks, and so individuals’ consumptions will move together (Townsend, 1994: 540).

General derivations in the risk sharing model can be found in Mace (1991: 928-956), Cochrane (1991: 957-976), and Townsend (1994: 539-591). Here we provide only a brief derivation. Let \( i = 1, \ldots, N \) index the households that live in the village. There are \( T \) periods, indexed by \( t \). The state of nature \( S \) is indexed by \( s \), and \( \pi_s \) is the probability of occurrence in each state of nature. Suppose that the utility
function, which is presumed to be additively separable across time and states, for each household \( i \) is

\[
T \sum_{t=1}^{T} \sum_{s=1}^{S} \pi_s U_i(C_{ist}, Z_{ist}),
\]

(138)

where \( \delta^t \) is the discount factor, and \( C_{ist} \) and \( Z_{ist} \) are the consumption and preference shocks respectively of household \( i \) if state \( s \) occurs in period \( t \).

A Pareto-efficient allocation of risk within the village can be found when a social planner efficiently allocates consumption across households. She does this by maximizing the weighted sum of the utilities of each of the \( N \) households, where the weight of household \( i \) in the Pareto programme is \( \omega_i \), \( 0 < \omega_i < 1 \), \( \sum \omega_i = 1 \):

\[
\max \sum_{C_{ist}} \omega_i T \sum_{t=1}^{T} \sum_{s=1}^{S} \pi_s U_i(C_{ist}, Z_{ist}),
\]

(139)

subject to the resources available in the village at each point in time in each state of nature:

\[
\sum_{i=1}^{N} C_{ist} = \sum_{i=1}^{N} Y_{ist}, \quad s, t,
\]

(140)

\[
C_{ist} \geq 0, \quad s, t,
\]

(141)

equation (140) is the set of village resources constraints. Equation (141) represents the non-negative constraints, which will not bind if the village has any resources in each period along each possible history (Bardhan and Udry, 1999: 96). In addition, we

---

98 Consumption might depend not only on the current state, but also on the entire history of states. However, if we assume that the utility function is time-separable, storage and borrowing across periods is not possible. The problem, therefore, separates by period and current consumption depends only on the current state (Bardhan and Udry, 1999: 95).
assumes $Y_{ist}$, which is income of household $i$ in state $s$ at time $t$, consisting of an individual-specific fixed effect $\mu_i$, aggregate shock $\mu_{st}$, and idiosyncratic shock $\nu_{ist}$:

$$Y_{ist} = \mu_i + \mu_{st} + \nu_{ist}. \tag{142}$$

If we take a derivative with respect to $C_{ist}$ and $C_{jst}$, the first-order conditions for the problem maximize (139) subject to (140) and (141) yield:

$$\omega_i U_i(C_{ist}, Z_{ist}) = \omega_j U_j(C_{jst}, Z_{jst}) = \lambda_t \quad \forall i, j, st, \tag{143}$$

where $\lambda_t$ is the Lagrange multiplier on the village resource constraint; i.e. the marginal utility of income. Equation (143) says that, with a perfect risk sharing condition, total village resources in any period are distributed across households so as to equate the weighted marginal utility of consumption across them. Furthermore, the social planner cannot transfer resources from one household to another and improve the weighted sum of their utility; at the optimum any further transfers reduce social welfare (Morduch, 2002: 9).

There are two main utility functional forms that are implemented to derive the consumption equation: constant absolute risk aversion (CARA) and constant relative risk aversion (CRRA)\textsuperscript{99}.

For the CARA utility function, the form of utility function is

$$U_i(C_{it}, Z_{it}) = -\frac{1}{\sigma} \exp \left( -\sigma(C_{it} - Z_{it}) \right), \tag{144}$$

where $\sigma$ is the Arrow-Pratt measure of absolute risk aversion. Using equation (143) then yields:

\textsuperscript{99} The CARA utility function is better for the purpose of exposition, while the CRRA specification may be better for purpose of estimation. The CRRA utility function is more attractive in the consumption cannot go negative. Moreover, its use results in consumption equations that typically fit the data better (Alderman and Paxson, 1992: 17).
Taking logs and rearranging, we have:

\[ C_{it} = \frac{1}{\sigma} \left[ \log(\omega_i) - \log(\lambda_i) \right] + Z_{it}, \]  

and averaging over the \( N \) individuals yields:

\[ \bar{C}_t = \frac{1}{\sigma} \left[ \log(\bar{\omega}) - \log(\bar{\lambda}_t) \right] + \bar{Z}_t, \]  

where

\[ \bar{C}_t = \frac{1}{N} \sum_{i=1}^{N} C_{it}, \]

\[ \log(\bar{\omega}) = \frac{1}{N} \sum_{i=1}^{N} \log(\omega_{it}), \]

\[ \bar{Z}_t = \frac{1}{N} \sum_{i=1}^{N} Z_{it}. \]

Subtracting then equation (147) from equation (146) and rearranging, we find:

\[ C_{it} = \bar{C}_t + \left[ \frac{1}{\sigma} \left( \log(\omega_{it}) - \log(\bar{\omega}) \right) \right] + (Z_{it} - \bar{Z}_t). \]  

Equation (148) indicates that three important implications. First, a household’s consumption depends on the average consumption of the village, a time-invariant household fixed effect which depends upon the relative weight of the household in the
Pareto programme and preference\textsuperscript{100}. Second, after controlling for average consumption, a change in household income ($\Delta Y_i$) does not affect its own consumption\textsuperscript{101}. Third, perfect risk sharing only protects against idiosyncratic rather than aggregate risks\textsuperscript{102}.

Consider then the CRRA utility function, following Krishnamurty (2000: 18); the form of utility function is

\[ U_i(C_{it}, Z_{it}) = \frac{1}{1 - \gamma} \left[ \frac{C_{it}}{e^{\gamma \alpha}} \right]^{1-\gamma}, \quad (149) \]

where $\gamma$ is the Arrow-Pratt measure of relative risk aversion. Applying equation (149) in equation (143) yields:

\[ \lambda_i = \omega_i \left[ \frac{1}{Z_{it} \alpha} \right]^{1-\gamma} C_{it}^{-\gamma}. \quad (150) \]

Taking logs, we get:

\[ \log(\lambda_i) = \log(\omega_i) - Z_{it} \alpha (1 - \gamma) - \gamma \log(C_{it}). \quad (151) \]

Rearranging the terms:

\[ \log(C_{it}) = \frac{1}{\gamma} \log(\omega_i) - \frac{1}{\gamma} \log(\lambda_i) - \frac{\alpha (1 - \gamma)}{\gamma} Z_{it}. \quad (152) \]

\textsuperscript{100} First differencing can eliminates a time-invariant household fixed effect implicit in equation (148) while the preference term can also be eliminated if we assume that preference do not change with time.

\textsuperscript{101} It may also note that $\bar{Y}_i$ does not appear in equation (148).

\textsuperscript{102} As the number of individuals in the insurance pool becomes large, the effect of idiosyncratic risks ($\bar{V}_{ist}$ in equation (142)) on village consumption goes to zero (Alderman and Paxson, 1992: 18).
and averaging over the $N$ individuals yield:

$$\log(C_t) = \frac{1}{\gamma} \log(\omega) - \frac{1}{\gamma} \log(\lambda_t) - \frac{\alpha(1-\gamma)}{\gamma} Z_t. \quad (153)$$

Subtracting equation (153) from equation (152) and rearranging, we get:

$$\log(C_{it}) = \log(C_t) + \left[ \frac{1}{\gamma} (\log(\omega_t) - \log(\omega)) \right] - \frac{\alpha(1-\gamma)}{\gamma} (Z_{it} - Z_t). \quad (154)$$

The CRRA utility function yields in an analogous consumption function with the CARA case but this is different in the logarithm form of variables. Therefore, both utility functions yield an overall conclusion in that in a Pareto-efficient allocation of risk within a village, a household’s consumption is determined by average village consumption and preference, and households face only aggregate risks because idiosyncratic risks are completely insured within the villages.

Nevertheless, it should be reminded that according to the second welfare theorem, we know that the Pareto-efficient allocation of risk can be supported by a competitive equilibrium with a completely contingent market. However, the notion that such a rich set of competitive markets exits is incredible because any risk pooling mechanism may not overcome the information and enforcement problems associated with insurance contracts. Consequently, a complete set of markets will not exist and the competitive equilibrium will not be Pareto-efficient. Therefore, to achieve efficient (or nearly efficient) risk pooling, other mechanisms, such as gifts and transfers may be implemented to support (Bardhan and Udry, 1992: 97-98).

There is a large body of literature which tests whether households within villages, regions, and even countries fully share risk. However, most of this literature rejects full risk sharing for at least some specifications. Among this literature, the work that is the most supportive of risk sharing includes, for example, Mace (1991: 928-956), who tested the implications of full consumption insurance using data from the Consumer Expenditure Survey (CES). He found that the first difference specification is mostly consistent with full consumption insurance. Nevertheless,
many of the results for growth specification rejected full insurance. Townsend (1994: 539-591), using data from three poor, high risk villages in the semi-arid topics of southern India tested for risk sharing. The results revealed that household consumptions are not very much influenced by contemporaneous own income, sickness, unemployment, or other idiosyncratic shocks, controlling for village consumption. In addition, household consumptions co-move with village average consumption.

Cochrane (1991: 957-976) was the primary empirical study that rejected full insurance. He tested cross-sectional regressions of consumption growth on a variety of exogenous variables. His results rejected insurance for long illness and involuntary job loss but not for spells of unemployment, loss of work due to strike, and an involuntary move. Since Thai household data are not available, Townsend (1995 : 83-102) tested full risk sharing by running regression equations for the sample countries or amphoe in the entire kingdom of Thailand, also distinguishing each of the five regions separately. The results rejected full risk sharing. Consumption in an amphoe does move with the income in that amphoe. Ravallion and Chaudhuri (1997: 171-184) reestimated Townsend’s (1994: 539-591) specifications, as well as estimated their own specifications, using the same data set but using different in consumption measurements. The estimates for all three villages indicated that consumption changes were sensitive to idiosyncratic income changes, and thus this implies that there is a failure of complete intra-village consumption insurance. As suggested by anthropology and geography that Ivorian households engage in risk-sharing arrangements with other members of their kinship group, Grimard (1997: 391-422) investigated whether there was complete risk sharing with the ethnic groups of households in Cote d’Ivorie. His results rejected the hypothesis of complete risk sharing within ethnic groups. There nonetheless appeared to be some partial insurance performed by individual households with other members of the same ethnic group, particularly for the households residing in the regions that were least likely to have access to formal financial arrangements. Jalan and Ravallion (1999: 61-81)

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The dependent variable is change in average log amphoe (district) consumption and independent variables are change in region and community type average log consumption and change in average log amphoe income in this case.
investigated the extent of consumption insurance in post-reform rural China, using household-level panel data. Partial insurance was indicated for all wealth groups, although the hypothesis of perfect insurance was universally rejected. However, the rejection of full insurance was different among wealth deciles in that the lower a household’s wealth, the stronger is the rejection.

Dercon and Krishnan (2000: 688-727) used data from rural Ethiopia to test whether individuals can smooth nutritional levels over time and tested whether households act as risk sharing institutions so that nutritional levels are smooth across members of the households. They found that poor households are affected by household specific shocks in agriculture. By using unpredicted illness shocks as an individual idiosyncratic shock, they found that full risk-sharing of illness shocks takes place in most households. However, households did not pool the illness shocks to women in poor Southern households. Gertler and Gruber (2002: 51-70), using a unique panel data set from Indonesia, investigated the extent to which households are able to insure consumption against illness. They found that there are significant economic cost associated with major illness, and that there is very imperfect insurance of consumption over illness. Carter and Maluccio (2003: 1147-1163) examined the role of social capital through the effects of shocks on child nutritional status. Their results showed that some households were unable to insure against risks, particularly when others in their communities simultaneously suffer large losses. Nevertheless, they found that households in communities with more social capital seemed better able to insure against weather shocks. Fafchamps and Lund (2003: 261-287) investigated risk sharing networks using data from four villages in the rural Philippines. The regression results showed that shocks have a strong effect on gifts and informal loans, but little effect on sales of livestock and grain. However, gifts and loans appear, by themselves, unable to efficiently share risk at the village level; rather, households receive help primarily through networks of friends and relatives. Skoufias (2003: 67-91) used panel data from the Russian Longitudinal Monitoring Survey (RLMS) to test for risk sharing. The results indicated that consumption was only partially insured from idiosyncratic income shocks, with food consumption being better insured more than non-food consumption. In addition, he found that there partial insurance took place among households within the same community. Also, he
found that households were different in terms of their vulnerability as a result of differences in certain characteristics. Furthermore, his results showed that households complement their self insurance strategies, of borrowings, adjusting their labor supply and selling assets, with informal risk sharing arrangements with households within their community.

Skoufias and Quissumbing (2003: 1-41) examined the extent to which households were able through formal and/or informal arrangements to insure their consumption from specific economic shocks and fluctuations in their real income using household panel data from Bangladesh, Ethiopia, Mali, Mexico and Russia. All of the case studies show that food consumption is better insured than nonfood consumption from idiosyncratic shocks. Additionally, all of the case studies show that households use a portfolio of risk-coping strategies, but that different types of households may have differential abilities to use these strategies. In particular, poor households may be less able to use mechanisms that rely on initial wealth as collateral. Harrower and Hoddinott (2004: 1-29) explored risk sharing in the Zone lacustre, Mali, as viewed through the lens of consumption smoothing. Their principal finding as that idiosyncratic shocks appeared to have little impact on consumption, and that households responded to these shocks in a variety of ways, in that non-poor households were more likely to enter into new income-generating activities while poor households were more likely to engage in’ credit or gift exchange or to ration consumption. A stronger test of consumption smoothing shows that - controlling for covariate shocks - changes in household income lead to modest changes in consumption. Covariant shocks, as measured by village/round dummies, always lead to changes in consumption. Lastly, they found that households with access to improved water control infrastructure are less vulnerable than those that rely on rainfall or the flooding of the Niger River. Based on monthly data from a panel of households in Bulgaria, Skoufias (2004: 328-347) investigated the extent to which households were able to protect their consumption from fluctuations in real income. His empirical analysis revealed that consumption was only partially insured from idiosyncratic fluctuations in income. Additionally, he found that households were able to insulate their food consumption from fluctuations in income by adjusting their
non-food expenditures and by borrowings through formal and informal credit markets, however, this mechanism was limited for the case of household transfers.

By using synthetic panel techniques to investigate the relationship between the relative male wages and household consumption in Mexico, Attanasio and Szekely (2004: 1-25) tested the hypothesis of both risk sharing across groups with means and risk sharing within group with variances. They found that for nondurable goods consumption, the hypothesis that Mexican households were able to ensure idiosyncratic risk was rejected on means, while those for the variances were more mixed. Based on two-year panel data of rural households in rural Ethiopia, Asfaw (2004: 115-129) examined the impact of illness on household consumption and the capacity of inter and intra risk sharing arrangements in insuring consumption against illness. His results showed that illness had a statistically-significant negative impact on stability of consumption and that the capacity of households or existing intra and inter households risk sharing arrangements in insuring consumption against illness varied across different consumption items. Weerdt and Dercon (2006: 337-356) investigated the role of networks in insuring idiosyncratic shocks, such as illness, using panel data from a village in Tanzania with information on all self-reported insurance network links. Their results showed that the hypothesis of full risk sharing could not be rejected for food consumption at the village level, but for non-food consumption they found evidence of partial insurance at the level of networks rather than the village. Kazianga and Udry (2006: 413-446) examined the consequences of severe income shocks generated by drought for the food consumption of a sample of farming households in rural Burkina Faso. The main findings were that there was little evidence of consumption smoothing either over time or across households within villages, in that there was almost no risk sharing, and the small amount of consumption smoothing that they found was effected largely through the accumulation and decumulation of grain stocks. Irac and Minoiu (2007: 153-173), using survey data on a representative sample of rural households from Romania tested the hypothesis of Pareto optimal risk sharing. They found no evidences against a Pareto-efficient allocation of consumption when Romanian rural households were faced with shocks to their income stream. They also found that poorer households were less able to cope with shocks than richer households.
Unlike most risk sharing literature which investigates risk sharing through the relationship between consumption and idiosyncratic risks, Fafchamps and Gubert (2007: 326-350) examined the formation of risk sharing networks by using a specifically designed survey in the rural Philippines. They found that geographic proximity was a major determinant of interpersonal relationships since it captured kith and kin relationships and facilitated monitoring and enforcement. Additionally, they also found that age and wealth differences played an important role in the formation of risk sharing links, while occupation was not a determinant of network links.

Skoufias (2007: 630-649) used three rounds of panel data of rural households in Mexico to investigate how the replacement of pre-existing subsidy programs by a conditional cash transfer program such as PROGRESA (the Health, Education and Nutrition Program) affected the consumption insurance of households. His results revealed that even if a comparison of the results between villages covered and not yet covered by PROGRESA (treatment versus control villages) suggested that PROGRESA did not replace or reinforce any pre-existing risk sharing among households within villages or led to any substantial changes in how households coped with shocks, households eligible for the PROGRESA benefits in the treatment villages were able to insult their consumption from fluctuations in income better than their counterparts in the control villages. By utilizing a test for complete risk sharing, Islam and Maitra (2012: 232-243) investigated the potential role of microcredit in enabling households to insure consumption against health shocks by using three rounds of a household level panel data set from Bangladesh. They found that households that had borrowed from microcredit organizations appeared to be better able to cope with health shocks in which they do not need to sell livestock or do not have to, to extent households that do not have access to microcredit need to, in order to insure consumption against health shocks.

6.3 Methodology

To test for full insurance based on the theoretical background in the previous section, we have to specify the empirical models and the econometric strategies that are used in this test. In addition, data description will be presented in this section also.
6.3.1 Empirical Specifications

The typical empirical model used for tests of full insurance usually estimates the excess sensitivity parameter; namely, the elasticity of household consumption with respect to idiosyncratic shocks. Specifically, the full insurance implication is that changes in household consumption are determined by changes in aggregate consumption rather than by changes in idiosyncratic shocks.

Empirical specifications for risk sharing tests generally are divided into two main models that follow two main preferences after first differencing equation (148) and (154) to eliminate a time-invariant household fixed effect. Mace (1991: 935-936) present the first specification for the CARA utility function of the form:

\[ \Delta C_{it} = \beta_1 \Delta \overline{C} + \beta_2 \Delta Y_{it} + u_{it} \]

where \( \Delta C_{it} \) and \( \Delta Y_{it} \) are the changes in household consumption and income respectively. \( \Delta \overline{C} \) is the change in average consumption and \( u_{it} \) is the disturbance term that includes the time-varying component of both household and aggregate preference shocks and might also include measurement errors from the consumption and income data.

Since risk sharing implications are also derived for a class of the CRRA utility functions, the empirical specification for this utility function is

\[ \Delta \ln C_{it} = \beta_1 \Delta \ln \overline{C} + \beta_2 \Delta \ln Y_{it} + \varepsilon_{it} \]

where \( \Delta \ln C_{it} \) and \( \Delta \ln Y_{it} \) are the growth rate of household consumption and income respectively. \( \Delta \ln \overline{C} \) is the growth rate of average consumption and \( \varepsilon_{it} \) is the disturbance term.

Each type of these specifications has been used to test for risk sharing by several authors. For example, Mace (1991: 928-956), Nelson (1994: 384-394), and

\[104\] Alternatively, even if several studies use the first different estimator to test is sharing, our study uses the fixed effect estimator as with Kazainga and Udry (2006: 413-466).

Either is base on the CARA utility function or the CRRA utility function, in practical, test for risk sharing may utilize one of four empirical specifications as follow (Hoddinott and Quisumbing, 2003: 26)

\[
\Delta \ln C_{htv} = \delta_{tv} D_{tv} + \sum_{i} \beta_i S(i)_{htv} + \gamma X_{htv} + \Delta \varepsilon_{htv}
\]

\[
\Delta \ln C_{htv} = \delta_{tv} D_{tv} + \beta \Delta \ln Y_{htv} + \delta X_{htv} + \Delta \varepsilon_{htv}
\]

\[
\Delta \ln C_{htv} = \alpha + \sum_{i} \lambda_i S(i)_{tv} + \beta \Delta \ln Y_{htv} + \delta X_{htv} + \Delta \varepsilon_{htv}
\]

\[
\Delta \ln C_{htv} = \alpha + \beta \Delta \ln Y_{htv} + \gamma \Delta (\ln Y_{tv}) + \delta X_{htv} + \Delta \varepsilon_{htv},
\]

where $\Delta \ln C_{htv}$ is the change in log consumption or the growth rate in total consumption per capita of household $h$, in village $v$ at time $t$. $S(i)_{tv}$ is covariate shocks and $S(i)_{htv}$ is idiosyncratic shocks. $D_{tv}$ is time-community dummies (round and community dummies interacted) which capture changes in the resource constraints faced by the community at different times. In other words, they are a proxy for the aggregate, community-level shocks to income. $X_{tv}$ is a vector of household or household head’s characteristics. $\Delta \ln Y_{htv}$ and $\Delta (\ln Y_{tv})$ is the growth rate of household income and average community income respectively. $\Delta \varepsilon_{htv}$ is a household-specific error term capturing changes in the unobservable components of household preferences and $\delta, \beta, \gamma$, and $\lambda$ are the vectors of parameters to be estimated.

\[105\] Applying each type of specification depends on type of shock data set in the questionnaire (see the details in Hoddinott and Quisumbing, 2003: 26-28).
Each specification differs in its representation of shocks but is similar in controlling for fixed household characteristics by estimating the model using household fixed effects. For the case in which its questionnaire can identify a variety of idiosyncratic and aggregate risks, equation (157) and (159) are appropriate. However, several surveys are not specifically designed for the testing of risk sharing. Equation (158) and (160) thus are compatible with this case.

Since there wave Thai household panel data is the general survey about socio-economic of Thai households, this paper thus applies equation (158) and (160) for testing for risk sharing. Several authors also utilize equation (158) for testing for risk sharing. These include Ravallion and Chaudhuri (1997: 171-184), Jalan and Ravallion (1999: 61-81), Morduch (2002: 1-19), Skoufias (2003: 67-91), Skoufias and Quisumbing (2003: 1-41), Harrower and Hoddinott (2004: 1-29), and Kazianga and Udry (2006: 413-446). A formal specification for equation (158) which is exploited in this study may be rewritten as follows:

\[
\Delta C_{itv} = \sum_{tv} \delta_{tv} (D_{tv}) + \beta Y_{itv} + \varepsilon_{itv} + \Delta S_{itv} + \Delta X_{itv} + \Delta Y_{itv}, \quad (161)
\]

where \( S_{itv} \) is an idiosyncratic shocks (the preference shifters). If there is perfect risk sharing within the villages, then household income will have no effect on consumption after controlling for common time-community (village) effects, \( i.e., \beta = 0 \). With concerning for the problem of endogeneity and measurement error on income variable, nonetheless, the instrumental variable technique is applied to equation (161).

To estimate income as an instrument variable, we apply the study of Fafchamps, Udry, and Czukas (1996: 273-305), Jacoby and Skoufias (1997: 311-335), and Kazianga and Udry (2006: 413 – 446) in setting income equation for agricultural households as follows:

\[
Y_{irt} = \alpha_1 X_{irt} + \alpha_2 R_{rt} \otimes Q_{irt} + \gamma_r + \lambda_t + u_{irt}. \quad (162)
\]
However, if we define $\gamma_n = \alpha_y R_n + \bar{y}_n$, and assume that $\bar{y}_n$ is uncorrelated with $X_{ir}$ and $Q_{ir}$, we then can rewrite equation (162) as

$$Y_{irt} = \alpha_1 X_{irt} + \alpha_2 R_{rt} \otimes Q_{irt} + \alpha_3 R_{rt} + \lambda_i + (\bar{y}_{rt} + u_{irt}), \quad (163)$$

where $Y_{irt}$ is household income, $R_{rt}$ is the deviation of rainfall from the long-run regional means and this deviation squared, $Q_{irt}$ is the farm characteristics that are determinants of income, such as the demographic structure of the household and detailed information on its landholding and its quality (Fafchamps, Udry, and Czukas, 1996: 288). $X_{ir}$ is a set of household characteristics. $\gamma_{ir}$ is a village-year fixed effect and $u_{irt}$ is the disturbance term. The Kronecker product ($\otimes$) generates an interaction terms.

Using the estimated income from equation (163), we then have another specification in this study:

$$\Delta C_{itv} = \sum_{tv} \delta_{tv} (D_{tv}) + \beta \Delta \hat{Y}_{itv} + \xi \Delta S_{itv} + \delta \Delta X_{itv} + \Delta \varepsilon_{itv}, \quad (164)$$

where $\hat{Y}_{itv}$ is the estimated income.

Generally, perfect risk sharing or full consumption insurance is difficult to find. Therefore equation (160) usually may be used to test for partial consumption insurance among households within the same community. Equation (160) is based on the idea that in a purely autarkic world, where there is no pooling of resources or risk sharing, the average community income $\bar{Y}_{rt}$ should have no impact on the consumption of any one household. Evidence that average community income has a significant role in household consumption (i.e., $\gamma \neq 0$) is consistent with the hypothesis that some risk sharing is taking place within communities (Skoufias and Quisumbing, 2003: 11). To test for partial consumption insurance therefore equation (160) may be written as
Applying the instrument variable, equation (165) may be written as:

\[ \Delta C_{itv} = \alpha + \beta \Delta Y_{itv} + \gamma \Delta (\bar{Y}_{vt}) + \xi \Delta S_{itv} + \delta \Delta X_{itv} + \Delta \varepsilon_{itv}. \]  

(165)

Finally, even though the previous specifications for risk sharing test provide a useful outlook for investigating whether there is risk pooling in the community, however, these tests provide little information about how risk is actually shared (Fafchamp and Lund, 2003: 265). To provide this information, we can test risk sharing through risk sharing instruments such as gifts, remittances and transfers.

Nevertheless, with the limitation of the data in the Thai household panel data, only the transfer mechanism is implemented. The final specification in this paper thus investigates whether transfers serve to efficiently share risks. To do this, we estimate random effect Tobit models of the form:

\[ \Pr (T_{it}^{Pri} > 0) = F(\Sigma_{itv} \delta_{itv} (D_{itv}) + \beta \Delta \hat{Y}_{itv} \\
+ \xi \Delta S_{itv} + \delta \Delta X_{itv} + \Delta \varepsilon_{itv}), \]  

(167)

where \( F \) is the cumulative normal distribution. \( T_{it}^{Pri} \) is transfer receipts from nonmember households, and \( S_{itv} \) is idiosyncratic shocks. If perfect risk sharing is implemented through a transfer mechanism, we expect \( \beta \) may be either negative or positive because it depends on whether the transfer motive is altruism or exchange. Since donor care concerning the well-being of the recipient in the altruism model, then the number of transfers received should increase as the recipient income decreases (\( \beta < 0 \)). On the other hand, if the donor does not care about well-being but

\[106\] Unlike Skoufias (2003: 67-91), this study also controls village-year dummy variables in this equation to capture all common shocks at the village level since there may be some shocks within the village which the village mean income cannot capture.
they expect return from the recipient in the case of the exchange model instead, then the transfers received may either increase ($\beta < 0$) or decrease ($\beta > 0$), as the decreasing of the recipient income depends on certain circumstances (Cox 1987: 508-546).

8.3.2 Econometric Techniques

Due to the use of panel data in this study, there are two main econometric techniques that are implemented. Fixed effect regression (FE) is applied to the study of the testing of full and partial insurance, while random Tobit regression is applied to the testing of the risk sharing instrument. The FE estimator is applied because it can solve the endogeneity problem by eliminating all unobserved, time-constant effect which it are thought to be correlated with the explained variables. Consequently, we can use the FE estimator to obtain the consist estimator. In addition the FE estimator used in this chapter is also a result of Sargent-Hansen test, which report a 1% level of significance for every equation. Unlike the test of full and partial insurance, we used random Tobit regression to test the risk sharing instrument equation. We implement this nonlinear panel data model for the risk sharing instrument equation since the transfer receipts from household nonmembers, which is our dependent variable, is a mixture of zero and positive value among the observations in this equation. However, since the details for these two techniques have already been explained in a previous chapter, they will not be explained in this section.

6.3 Empirical Results

Risk sharing arrangements are one of the alternative mechanisms which enable households to spread the effects of adverse shocks across households rather than through time. It is possible that many agricultural households in Thailand may behave in this way for several reasons, as mentioned in the introduction. By following the specifications, to examine risk sharing among Thai agricultural households, this section begins by testing whether there is full insurance among households. Next, it is further investigated whether there is partial insurance if full insurance is rejected. The
estimated income used in this chapter is adopted from a previous chapter without decomposing it. Lastly, to provide information about how risk is actually shared, risk sharing is tested through risk sharing instruments.

6.3.1 Test of Full Insurance

The estimates for equation (164) for household consumption are separately shown between country level and region level in table 6.1. Fixed effect regression is applied to this equation due to the significance at the 1% of the Sargent-Hansen test. As with most empirical studies, such as those of Cochrane (1991: 957-976), Townsend (1994: 539-591), Jalan and Ravallion (1999: 61-81), Morduch (2002: 1-19), Skoufias (2003: 67-91), Harrower and Hoddinott (2004: 1-29), and Kazianga and Udry (2006: 413-446), the null hypothesis of full insurance against income risks is rejected for both the entire country and some of regional levels in our study. Consequently, the regression results indicate that there may be partial insurance in the entire country as well as the group of Central, Eastern and Western regions because there is a positive, significant relationship between household income and household consumption. This partial insurance implies that there is either village-level insurance in some parts, or self-insurance by households, (Morduch, 2002: 12).

For the entire country, the results show that household consumption is quite well insured due to a closing zero of the coefficient of household income. When we compare the entire country and the group of Central, Eastern, and Western regions’ results, which hypothesized that there is partial insurance, we find that household consumptions appear to be better insured in the group of Central Eastern and Western regions than for the entire country. This may be explained by the hypothesis that the poor are likely to insure less because they tend to be rationed in terms of access to credit and insurance (Jalan and Ravillion, 1999: 62). Evidence consistent with this hypothesis is also found in the study of Jalan and Ravillian (1999: 61-81) and Kazianga and Udry (2006: 413-446). In the case of Thailand, it is difficult to reject the notion that household income in the group of Central, Eastern and Western regions is much higher than in other regions on the average. Thus, it is very possible that the households in the group of Central, Eastern and Western regions are likely to better insure. Surprisingly, it is also found that household consumption appears to be
Table 6.1 Fixed Effect Regressions: Test of Full Insurance

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<td>(7912.934)</td>
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<td>(5820.497)</td>
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| Number of observations | 5648 | 1325 | 745 | 2819 | 759 |
| R-squared | 0.134 | 0.173 | 0.139 | 0.231 | 0.263 |
| Sargent and Hansen test | 9.5e+06*** | 7516.057*** | 2.3e+04*** | 1.6e+04*** | 1.5e+05*** |
| F-test (village-year dummies - jointly insignificant) | 169.520*** | 309.600*** | 1316.470*** | 67.500*** | 640.440*** |

Notes: 1.) All regions = (1), Northern region = (2), Southern region = (3), Northeastern region = (4), and Central, Eastern and Western regions = (5)  
2.) Robust standard errors in brackets under coefficients  
3.)* significant at 10%; ** significant at 5%; ***significant at 1%
completely insulated for income shocks in the Northern, Southern and Northeastern regions. This is consistent with Skoufias and Quisumbing (2003: 1-41), and Weerdt and Dercon (2006: 337-356) in some specifications. Nevertheless, at this point, it should also be noted that there is the consistency of results in the three studies, where only the household in the group of Central, Eastern and Western regions are found to be unable to smooth consumption due to income shocks in our first study, and then they are also found to use savings as consumption smoothing mechanism less than other regions in the second study, while they is households only in one region which consumption does not appear to be completely insulated in this study.

In addition to testing full insurance through the investigation of the co-movement between household consumption and household income, the impact of a specified adverse shock, proxied by illness of household head on household consumption, is also examined as an alternative test of complete risk sharing. The results show that this type of shock appears to be fully insured for households in the entire country and in the Northern, Northeastern, as well as the Southern regions. Illness of household head has a negative, significant effect on household consumption at the 1% level only in the group of Central, Eastern, and Western regions. This indicates that the households in these regions are unable to insulate their consumption from this type of shock. The different impacts of illness of household head on household consumption in this study are consistent with several studies, such as those of Skoufias and Quisumbing (2003: 1-40), Harrower and Hoddinott (2004: 1-29), and Weerdt and Dercon (2006: 337-356). Contrary to both income shocks and a specific adverse shock, it is important to note that the F-statistic on the village (tambon)- year dummy variables all led to a rejection of the null hypothesis that aggregate shocks do not matter. These indicate that illness of the household head, which is only one type of specific adverse shock, has little significant impact on household consumption in Thailand, while aggregate shocks appear to be very important in explaining fluctuations in consumption.

\footnote{Specified adverse shocks are used as an alternative test of complete risk sharing because they can account for measurement error in income.}
Unlike the impact of adverse shocks, overwhelming evidence is found for the relationship between household consumption and a set of household characteristic variables in most regions. For the entire country, most household characteristic variables, except household members who are female and aged 6 to 11, are significant at the 1% level, while this evidence is also found for the Northern and Northeastern regions, even though there is slight difference in the case of household members whose age is under 12. On the other hand, there is a little evidence of the relationship between household consumption and the set of household characteristic variables for the Southern region, while this relationship appears moderately for the group of Central, Eastern and Western regions.

6.4.3 Test of Partial Insurance

Consequently, with test of full insurance, where it is hypothesized that there may be partial insurance in the entire country, together with in the group of Central, Eastern and Western regions, we investigate thus further this issue. The estimated coefficients of average village (tambon) income, which is focused on this section are reported in table 6.2. As expected, the estimates provide evidence in favor of partial insurance and community risk sharing in household consumption for the entire country, except for the Southern region. The average village income has a positive statistically-significant relationship with household consumption at the 1% level at the entire country level. This is consistent with the hypothesis that some risk sharing takes place within the villages in the entire country, or in other words, income shocks are shared among village members. Most of the studies, which test both full insurance and partial insurance, found this consistency between these two tests, for instance, Skoufias (2003: 67-91), Skoufias and Quisumbing (2003: 1-41), and Harrower and Hoddinott (2004: 1-29). Moreover, it should be noted that there is a clearly consistency between the test of full insurance and the test of partial insurance for the whole country. On the test of full insurance, it is found that household consumption appears to have some level of insurance, and thus this implies that there may be village-level insurance at some part. The results of the test of partial insurance in this section support fully the evidence in which the coefficient of average village income is large and statistically significant at the 1% level for households in the entire
### Table 6.2 Fixed Effect Regressions: Test of Partial Insurance

**Dependent variable: Household Consumption**

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| Number of observations | 5648 | 1325 | 745 | 2819 | 575 |
| R-squared | 0.018 | 0.141 | 0.010 | 0.114 | 0.227 |
| Sargent and Hansen test | 7.0e+06*** | 1.2e+04*** | 5.2e+04*** | 1.7e+04*** | 1.6e+05*** |
| F-test (village-year dummies - jointly insignificant) | 11975.090*** | 309.970*** | 16567.950*** | 58.900*** | 573.290*** |

**Notes:**
1. All regions = (1), Northern region = (2), Southern region = (3), Northeastern region = (4), and Central, Eastern and Western regions = (5)
2. Robust standard errors in brackets under coefficients
3. * significant at 10%; ** significant at 5%; ***significant at 1%
country. This reaffirms that income shocks are evidently shared among village members at the country level.

On the other hand, even though the results for the test of full insurance show that there may be partial insurance for the group of Central, Eastern, and Western regions, no evidence of risk sharing within villages is found in these regions. This is similar to the studies of Skoufias and Quisumbing (2003: 1-41), and Harrower and Hoddinott (2004: 1-29), where it is implied that these types of households are more autarkic in their behavior, rely more on entry into other income activities than pooling risk with other village members. We find also that there is significant co-movement between household consumption and average village income in the Northeastern region, even if its sign is negative and the results on test of full insurance reveal no significant relationship between household consumption and household income. However, this is not surprising evidence; both the study of Skoufias (2003: 67-91), and Skoufias and Quisumbing (2003: 1-41) as well as that of Harrower and Hoddinott (2004: 1-29) found also this type of evidence. If the sign is positive for the case of Northeast region, Skoufias (2003: 79) indicated that there is the possibility that there are some circumstances where this type of evidence can occur, for example, the case where a lot of shocks are common and everybody uses self-insurance.

Similar to the test of full insurance, we investigate further the impact of the specific adverse shocks proxied by illness of household head on household consumption. The regression results still are not different from the test of full insurance, in which illness of the household head has a negative, significant effect on household consumption in the group of Central, Eastern, and Western regions, while this type of shock appear to be fully insured against for households, in other regions. On the other hand, since aggregate shocks cannot be insured or smoothed out by households within villages, aggregate shocks captured by the village (tambon)-year dummies appear still to be very important in explaining the fluctuations in consumption in this test also. At this point, therefore, we may conclude that household consumption co-moves with the aggregate resource constraint in every region, while both income shock and the specific adverse have little significant impact on household consumption in Thailand. To complete this test, a set of household characteristic variables are also examined. The regression shows yet similar results
with the test of full insurance. The set of household characteristic variables, especially the variable of household members whose age is over 11, appear evidently in the relationship with household consumption in most regions, while there are few significant relationships between these two variables in the Southern region.

6.4.3 Test of Risk Sharing Instrument

The test of full insurance as well as partial insurance in the previous section tells us whether there is risk pooling at the village level in some regions of Thailand. These two tests do not nevertheless provide information about how risk is actually shared. This section investigates the relationship between the risk sharing instrument (i.e. transfer receipts from household nonmembers) and household income, including illness of household head, which is a proxy for idiosyncratic shock.

Table 6.3 reports the response of transfer receipts from household nonmembers by using random effect Tobit regression. The log likelihood value presents the lowest value in the group of Central, Eastern, and Western regions, while it is the opposite for the entire country. There is evidence that income shock is insured by transfer receipts from household nonmembers in the case of the entire country and for the Southern and Northeastern regions. The coefficients of transfer receipts from household nonmembers are positively significant at the 1 % level in these three sample groups. This implies that exchange may be the underlying motive. Several previous studies support this evidence, such as those of Cox (1987: 508-546), Cox and Jakubson (1995: 129-167), and Cox, Eser, and Jimenez (1998: 57-80). Although it is difficult to explain why this evidence appears only in these regions, one of the plausible explanations is that there may be better social networks in these regions. These social networks are not only informal, based on kinship, friendship or religion, but also are semi-formal organizations such as savings groups, and women’s groups, which may require membership and fees, and provides support to their members in bads. Good social networks are primarily condition of risk sharing achievement, and surely other regions also have social networks. Having a social network does not nonetheless guarantee the attainment of risk sharing, and a well-functioning social network is a warranty instead. Thus, having good social networks may be a plausible explanation for the response of transfer receipts from household nonmembers to the
### Table 6.3 Random Effect Tobit Regressions: Test of Risk Sharing Instrument

**Dependent variable:** Transfer receipts from nonmembers of household

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<td>(4383.113)***</td>
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**Number of observations:** 5648  1325  745  2819  759
**Number of censored observations:** 3371  861  497  1495  518
**Log likelihood:** -30484.235  -6389.753  -3221.608  -17466.180  -3207.627
**F-test (province-year dummies insignificant):** 362.910***  71.120***  50.730  144.220***  60.020

**Notes:**
1.) All regions = (1), Northern region = (2), Southern region = (3), Northeastern region = (4), and Central, Eastern and Western regions = (5)
2.) standard errors in brackets under coefficients
3.) * significant at 10%; ** significant at 5%; ***significant at 1%
income shock in these regions. Morduch (1999: 190) indicated that the household’s social networks matter, where households with more friends have a greater ability to use informal insurance, while households that are not so well connected fare much worse. However, this leaves room for the further study in proving these plausible explanations. Additionally, it should be noted that the results from this test are another distinction of evidence of the household in the group of Central, Eastern, and Western regions because these regions are still a region which transfer receipts from household nonmembers that is a main instrument of risk sharing is insignificant, while it is significant in most regions.

No significant impact of illness of household head on transfer receipt from household nonmembers is found for any region. This indicates that this type of idiosyncratic shock is not insured by household nonmember’s transfer receipts. Three remarks need to be made concerning the relationship between transfer receipts from household nonmembers and a set of household characteristic variables. First, the household head’s age is positively significant at the 1% level in the Northern and Northeastern regions, and at the 5% level in the Southern group and the group of Central, Eastern and Western region. This is consistent with the study of Ravallion and Dearden (1988: 36-44), and Pan (2007: 1-35), which indicated that this relationship reveals targeting toward being old of household head for this type of transfer. Second, household members whose age is under 6 are also targeted since this variable is positively significant for most regions, especially in the Northern region, where a large positive significance is revealed. Finally, it should be noted that all significant variables of household members whose age is over 11 has a negative relationship with this type of transfer in every region. This shows that the households that have more adult members as well as individuals with a higher level of education, the less is the likelihood of transfer receipts from household nonmembers.

6.5 Conclusion

Most informal insurance mechanisms often provide only inadequate protection, or even if they can provide it, they might be costly for poor households. The theory of perfect risk sharing predicts nevertheless that if villages perfectly pool
their incomes to share risks, the household’s own income realization should not affect consumption patterns and all idiosyncratic shocks should be removed. This extension part uses three-wave Thai household panel data from 2005 to 2007 in investigating the existence of risk sharing among Thai agricultural households through three tests; that is, a test of full insurance, a test of partial insurance, and a test of risk sharing through risk sharing instruments respectively.

The null hypothesis of full insurance against income risks is rejected for the entire country, together with the group of Central, Eastern and Western regions. Household consumption appears to be better insured in the group of Central, Eastern and Western regions than the entire country’s case. Surprisingly, it is also found that household consumption appear to be completely insulated from income shocks in the Northern, Southern, and Northeastern regions. Unlike income shocks, a specific adverse shock, proxied by illness of household head, is fully insured against for the households in the entire country, as well as the Northern, Northeastern, and the Southern regions. Only households in the group of Central, Eastern, and Western regions appear to be unable to insulate their consumption for this type of shock. Consequently, with the test of full insurance, further study support the existence of evidence of partial insurance and community risk sharing for the whole country but the group of Central, Eastern and Western regions. Illness of household head still has a negative effect on household consumption only for the group of Central, Eastern, and Western regions in this second test. Income shocks are found to be insured with transfer receipts from household nonmembers for the entire country as well as in the Southern and Northeastern regions. Contrarily, illness of household head is not insulated by this type of transfer in for any region. The results show also that the household head who is elderly and household members whose age are under 6 are targeted by transfer receipts from household nonmembers in most regions.
CHAPTER 7

CONCLUSION AND DISCUSSION

The theory of life-cycle-permanent income predicts that if there is a complete market for credit, or there are other consumption smoothing mechanisms, transitory income shocks should be smoothed away through these mechanisms, and thus they should not affect consumption pattern. Consumption behavior is nevertheless explained by the precautionary motive for saving hypothesis, in which consumption may be permitted to drop in order to preserve buffer stocks against the possibility of shocks; thus consumption does not necessarily respond one to one to permanent income, as explained by the PIH. These two hypotheses are examined for agricultural households in Thailand using three waves of Thai household panel data during 2005-2007. In addition, the risk-coping strategies of households were also examined through risk-coping strategies; that is, consumption smoothing over time through the two main mechanisms: savings and borrowings and consumption smoothing across households through risk sharing.

The results indicate that the consumption behavior of Thai agricultural households is not consistent with the PIH. Although we find a significant impact of transitory income shocks due rainfall variation, which is close to zero among households at the national level, this evidence is found only among households in the Central, Eastern, and Western regions when we examine at the regional level. Furthermore, there is no evidence of the relationship between permanent income and household consumption in any region, even though we find slight evidence for the entire country. In contrast with the evidence on the PIH, Thai agricultural households exhibit clearly the precautionary saving motives behavior both at national and regional levels. This implies that households drop their consumption to preserve their buffer stocks against future income shocks due to rainfall variation. Finally, aggregate shocks have a significant impact at national and regional levels when they are proxied
by village-year dummy variables. However, we find no impact of idiosyncratic shock when the shock is proxied by the household head’s illness.

Consequently, according to the finding, that there is little evidence of the relationship between transitory income shocks and household consumption, we find that, on average, Thai agricultural households heavily depend on their saving mechanism in smoothing their consumption; however, there is little evidence for using borrowings at the national level. The impact of transitory income shocks due to rainfall variation on savings and borrowings in each region is different. The regressions shows that only savings has a significant relationship with transitory income in every region. We find no significant response of borrowings to transitory income in any region, while only households in the Northern region use work hours as a consumption smoothing mechanisms. With regard to transitory income, household savings appear to have a significant relationship with permanent income in every region, while only households in the Northeastern region do not respond to change in permanent income by increasing their borrowings. Contrary to the PIH, our findings show that savings has a significant relationship with variance of income only in the Northern and Northeastern regions, while no households in any region respond to future income uncertainty by borrowings. Similar to the consumption equation, households in none of the regions use their savings or borrowings to smooth consumption in response to the idiosyncratic shock, proxied by illness of the household head. Contrary to the results on the idiosyncratic shock, the regression results show overwhelmingly a significant relationship between aggregate shocks, proxied by village-year dummy variables, with savings and borrowings in every region except with the borrowings in the Southern region.

Similar to the results on the PIH, the null hypothesis of full insurance against income risk in the risk sharing model is rejected at the national level, together with the group of Central, Eastern and Western regions. This implies that only some agricultural households in Thailand are unable to smooth their consumption in the face of income shock. Surprisingly, we find also that household consumption appear to be completely smoothed under income shocks in the Northern, Southern, and Northeastern regions. Unlike income shocks, a specific adverse shock which is proxied by illness of household head is fully insured against for households in the
entire country, and the Northern, Northeastern, as well as the Southern regions. Only households in the group of Central, Eastern and Western regions appear to be unable to insulate their consumption against this type of shock. Consequently, with the test of full insurance, our study supports the evidence of partial insurance and community risk sharing for the whole country but not for the group of Central, Eastern, and Western regions. Illness of the household head has a negative effect on household consumption only in the group of Central, Eastern, and Western regions in this second test. At the national level we find that income shocks are insured by transfer receipts from household nonmembers as well as in the Southern and Northeastern regions. Contrarily, the illness of the household head is not insulated by this type of transfer in any region. The results show also that a household head that is elderly and household members whose age is under 6 are targeted by transfer receipts from household nonmembers in most regions.

There are some important policy implications which may be implemented as a result of this evidence. First, since consumption is one of the basic indicators of household’s welfare, and this study’s results show some evidence of the impact of income shocks due to rainfall variation at least at some level and in some regions, to protect a household’s welfare from income shocks, as well as other adverse shocks such as pest attack, diseases of crops, and price risks, the government should provide and promote either consumption or income smoothing mechanisms, especially for agricultural households in the group of Central, Eastern, and Western regions that face significantly income shocks due to rainfall variation, for example, increasing accessibility to formal institutions, especially for poor households, promoting and setting up microfinance institutions such as saving groups, production credit groups, rice banks, etc., as well as providing and promoting the use of risk insurance for agricultural products and promoting the diversification of economic activities. Nevertheless, it should be noted that rainfall variation, which affect household income in this study, may be just a small or transitory income shocks, but not a big or persistence shock. If a shock persists for many periods, it hardly reject to its worse impact. Therefore, in order to ensure that household welfare is not to any great extent deteriorated from these shocks, the government should not only provide or promote either consumption smoothing mechanisms which can protect households from only
transitory shocks, but also should improve, effectively both management and the infrastructure of irrigation system so that they can bear global climate change.

In addition, since climate change is an inevitable phenomenon, and it affects clearly and directly agricultural households, providing a knowledge through education, training, and essential information (e.g. climate trends, weather forecasts, exist strategies, including introducing new technologies and production methods) should also be one of the policies of the government for protecting household’s welfare, especially agricultural households. Furthermore, although transitory income shock has little impact on household consumption, household consumption also can be reduced by the effect of future income uncertainty as a result of the precautionary saving motive of households. To protect the fall of household consumption due to this uncertainty, the government should also promote savings seriously and systematically. Savings not only protect household consumption from a decline, but also shield households from the impact of adverse shocks.

Second, as a result of the finding that savings is used as a consumption smoothing mechanisms in every regions, the government should promote and support saving behavior through both a direct and indirect approach, for example, controlling inflation to induce the saving motive of households, encouraging the use of household accounting practices, establishing and supporting formal and informal financial institutions for farmers to increase their saving channel, increasing financial access from the existent financial intermediations, extending and supporting retirement saving programs to cover households in every occupation, especially agricultural households, and controlling luxury consumption through interest rate policy and controlling easy credit. However, it should be noted that household savings will be implemented for two purposes (i.e. absorbing transitory income shock as well as lessening the risk of future income uncertainty), promoting and supporting saving should thus be insured that there is also the adequacy of household savings for serving both purposes.

Third, borrowings are usually the primary mechanism of households that have no savings or any assets to smooth their consumption, especially the poor households. Meanwhile our results show, for the entire country, that borrowings are also used as a shock absorber due to adverse shocks for some households, even if there is little
evidence of the use this mechanism. This may be due to a limitation in the access to financial institutions. Therefore, in addition to promote savings, which is a long-run policy, in the short-run, providing credit sources for these households should be implemented. Nevertheless, it is generally accepted that access to formal financial institutions is difficult for agricultural households, especially those that are poor and lack collateral assets. Providing and promoting informal financial institutions, especially at the community level, such as village funds, saving groups, production credit groups and other forms of microfinance institutions, will lessen the asymmetric information problem; then the financial access for poor households can be enhanced.

Finally, although we find that most regions completely insure their consumption, we find also that the households in the entire country and the group of Central, Eastern, and Western regions do not appear to be completely insulated against income shocks. Thus, the government should promote and support community activities, including the participation of households within the community so that they can contribute to the community’s social capital, and then increase the level of risk sharing. Morduch (2002: 4) indicated that economists have considered the village to be a natural insurance unit. The problems of imperfect information and costly enforcement which hinder broad-based insurance markets can be alleviated at the village level. Setting up risk sharing within communities might therefore be one of the most economical and most efficient investments in creating a social protection system. Nevertheless, to create effectively this system, the government should also identifies which households are less insured or are feeble in the face of adverse shocks, as investigated in this study, instead of searching for those that are the poor only. Moreover, transfers from household nonmembers are found to be basic risk sharing instruments. This reflects the philanthropy of individuals and households, and can create harmony and strength for communities and then for the country. Additionally, the existence of this type of risk sharing instrument can partly reduce the burden of the government in aiding people when they face adverse shocks. However, as reported in this study, the results show little evidence of the response of transfer receipts from household nonmembers to adverse shocks. This implies that instrument function poorly in most regions of Thailand. Together with this evidence, if other informal insurance mechanisms are also weak, households, especially the
poor households, in those regions, will face substantial hardship. At this point, transfers from the government can be reimbursed to replace the poor function of transfers from household nonmembers. Morduch (1999: 193) has indicated that public transfer systems may be more efficiently delivered than private transfers, and then yield a net gain for society. Transfers from household nonmembers can therefore be complemented with transfers from the government to protect a household’s welfare from adverse shocks. One should not nevertheless ignore the possibility of the crowding out of existing informal mechanisms due to the implementation of transfers from the government, as suggested by Cox and Jimenez (1995: 321-334). Public policy on risk sharing should provide ways to strengthen informal insurance mechanisms and broaden their accessibility rather than displace private actions (Morduch, 1999: 198). These policies, which are mostly an indirect intervention, include promoting savings, providing a supportive setting for institutions working to improve to credit, such as microfinance institutions, implementing crop and health insurances, and employment guarantee schemes.

The limitations of the study

Although, for the first time, this study examines the impact of income shocks and income uncertainty on Thai agricultural households by using the Thai household panel data set, which covers households all over the country, this data set has some limitations for this study. First, this data set has fewer samples and details than the Thai Socio-Economic Surveys (SES). Furthermore, this data set is just a socio-economic survey, just like the SES. It is not designed to examine directly the impact of adverse shocks on Thai households. Therefore, both types of shocks and mechanisms, which households may actually utilize when they face adverse shocks, are limited. Only some of the shocks and mechanisms provided by the data can be used in this study. Second, even if our data are panel data, which has some advantages more over both time-series and cross-sectional data, this data set is of the short panel data type. Short panel data have some disadvantages, especially when we need to construct some variables, which require a long time-series, such as standard deviation and variance of variables. This study also faces this problem when the income
uncertainty variable is constructed. However, this study try to fix this problem by using Kazianga and Udry’s (2006: 434) technique by estimating income variance with the time-series of rainfall variation which interacted with household land characteristics and weighted by the estimates from the income equation.
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45(2): 233-258.


## Appendix A:

Selected rainfall stations and its means and standard deviation of rainfall

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<th>Std.</th>
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</table>
BIOGRAPHY

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