

Lincoln University Digital Thesis

Copyright Statement

The digital copy of this thesis is protected by the Copyright Act 1994 (New Zealand).

This thesis may be consulted by you, provided you comply with the provisions of the Act and the following conditions of use:

- you will use the copy only for the purposes of research or private study
- you will recognise the author's right to be identified as the author of the thesis and due acknowledgement will be made to the author where appropriate
- you will obtain the author's permission before publishing any material from the thesis.

**Effects of credit and non-credit support program on rural
households in Thailand: an empirical analysis of agricultural
cooperatives**

A thesis
submitted in partial fulfilment
of the requirements for the Degree of
Doctor of Philosophy in Economics

at
Lincoln University
by
Jumtip Seneerattanaprayul

Lincoln University

2019

Abstract

Effects of credit and non-credit support program on rural households in Thailand: an empirical analysis of agricultural cooperatives

by

Jumtip Seneerattanaprayul

Several studies have found that microcredit is unsuccessful in increasing rural household's socioeconomic welfare. To improve the effectiveness of credit, researchers suggest that non-credit support services should be provided alongside financial support. Despite Thailand agricultural cooperatives (ACs) offering such services, Thailand poverty rates remain high, particularly in rural areas. Low participation rates may explain why ACs have been largely ineffective in improving rural household welfare. This study investigates the reasons behind low AC member participation rates to increase their effectiveness, improve rural Thai households' socioeconomic welfare, and ultimately decrease Thailand's poverty levels.

We used rural household survey data from the Nakhonratchasima province, in Northeast Thailand. Data was collected from AC members and non-members in 2017 using a two-stage stratified sampling technique. Our study used the probit model to estimate the probability of AC participation and the Heckman selection model to examine determinants influencing AC service participation and participation levels. Using the Endogenous Switching Regression and Endogenous Switching Probit models, this study evaluated the effects of AC credit and non-credit support services on rural Thai households' socioeconomic welfare.

Our results reveal that social networks play a significant role in motivating households to join ACs credit and support services. Households residing in an AC village are more likely to become AC members and participate in AC services due to easy access and low travel costs. ACs assist largely middle-class households in accessing credit and markets; poor households still have difficulties accessing credit services. Lastly, perceptions of agricultural risks and the expected benefits of membership impact on households' decisions to participate in ACs. Members who believe that ACs can help them obtain credit are more likely to join. Households use marketing services because they believe ACs provide quality inputs and farm products at reasonable prices.

The ESR and ESP model results reveal that AC service participation plays an important role in improving household socioeconomic welfare. AC credit has a significant positive effect on household and farm income, and household consumption. In contrast, AC marketing service participation increases household and farm income, but not consumption. AC credit and marketing services do not improve educational expenditure and school enrolment rates. While AC credit considerably increases the adoption of improved farm technologies and practices, using AC agricultural extension services does not improve farm production. Households' health affordability and health access improve when they borrow money from, or trade with ACs. AC marketing services are more effective than AC credit in improving household welfare.

To improve AC credit and AC support service participation, households must reduce their agricultural risks and improve their agricultural production capacities. One practical way is through participating in government-run agricultural development projects. To ensure the government farm development projects reach their target population, ACs should provide their members with advice about the program's suitability. Moreover, ACs can increase service participation rates through providing farmers with specific information about the benefits of joining a cooperative, redesigning their service policies, and developing AC networks. ACs should also offer their services to poorer households if they meet certain criteria.

Keywords: Credit, non-credit support services, agricultural cooperatives, household welfare, Thailand.

Acknowledgements

The completion of this thesis would not have been possible with the support and encouragement of many people. I am deeply grateful to my supervisor, Professor Christopher Gan, for his excellent supervision. He has provided me with invaluable advice and guidance on this study. Moreover, he has always encouraged me to develop my ideas. I would also like to express my gratitude to my associate supervisors, Dr Cuong Cao Nguyen and Dr Baiding Hu. Thank you for being supportive and for your invaluable comments throughout the course of my study.

I am also very thankful for the support of the Agricultural Cooperative officers who helped me to collect data and especially for the individuals from Nakhonratchasima who participated in my survey. Your willingness to share information with me made this thesis possible; without it, I would not have been able to complete this PhD. I am also grateful for the survey team who helped me collect the data. I would like to thank my sisters who assisted me with survey management and Kittu who helped with database development.

Moreover, I would like to thank my colleagues at Lincoln University who have assisted me in various ways. Thank you to Bayu, Adlin, Ha, Borworn, Kongchheng, and Cephas for sharing your knowledge with me. Thank you to Kittu, Mina, Diem, Ida, and Jacob who always cheered up me and have helped me to overcome various obstacles. Special thanks to Dr Rebecca Kambuta and Caitriona Cameron who have edited my work and provided me with tips on how to improve my writing.

Finally, I would like to dedicate this thesis to my family. I am deeply grateful for my parents' love and unconditional support. My sisters and my brother inspired and encouraged me to complete this thesis.

Table of Contents

Abstract	ii
Acknowledgements	iv
Table of Contents	v
List of Tables	viii
List of Figures	x
Abbreviations.....	xi
Chapter 1 Introduction	1
1.1 Introduction	1
1.2 Rural Poverty and Agricultural Cooperatives in Thailand	4
1.3 Research Problems and Questions	10
1.4 Research Objectives.....	12
1.5 Contribution of the Study	13
1.6 Structure of the Thesis.....	13
Chapter 2 Overview of Agricultural Cooperatives in Thailand.....	14
2.1 Cooperative Concept	14
2.1.1 Cooperative Definition and Principles	14
2.1.2 Different Types of Cooperatives	15
2.2 Overview of Agricultural Cooperatives in Thailand	16
2.2.1 The Cooperative Movement in Thailand	16
2.2.2 Current Status of Agricultural Cooperatives in Thailand	19
2.2.3 Agricultural Cooperative Challenges and Innovations.....	25
2.3 Role of Agricultural Cooperatives in Thai Rural Economy	33
2.3.1 Role of Agricultural Cooperatives in Rural Financial Markets in Thailand.....	33
2.3.2 Role of Agricultural Cooperatives in the Thai Agricultural Market.....	36
2.4 Role of Agricultural Cooperatives in Poverty Reduction	39
2.4.1 Role of Agricultural Cooperatives in Poverty Reduction.....	39
2.4.2 Role of Agricultural Cooperatives in Poverty Reduction for Thai Rural Households.....	40
2.5 Chapter Summary	42
Chapter 3 Review of the Literature.....	44
3.1 Theory of Household Demand and Credit Rationing.....	44
3.1.1 Household Demand for Credit	44
3.1.2 Credit Rationing Theory	46
3.1.3 Agricultural Household Demand for Marketing Services.....	51
3.2 Participation in Credit and Non-Credit Support Service	55
3.2.1 Participation in Credit Services	55
3.2.2 Marketing Service Participation.....	68
3.2.3 Participation in Agricultural Extension Services.....	74
3.3 Effects of Cooperatives on Household Welfare	80
3.3.1 Impact Evaluation Method.....	80
3.3.2 Effect of Cooperatives on Households Welfare	84
3.4 Chapter Summary	88

Chapter 4 Research Methodology	90
4.1 Determinants of Participation in Agricultural Cooperative	90
4.1.1 Model Specification	90
4.1.2 Estimation Strategy	98
4.1.3 Addressing Potential Endogeneity	99
4.2 Effect Evaluation of Agricultural Cooperative at the Household Level.....	101
4.2.1 Outcome Indicators of Effect Evaluation	101
4.2.2 Empirical Model Specification.....	107
4.2.3 Estimation Strategy	112
4.3 Data Collection and Methods	114
4.3.1 Data Collection Method	114
4.3.2 Questionnaire Design.....	116
4.3.3 Sampling Method.....	116
4.3.4 Sample Size	117
4.4 Profiles of Sampled Households in the Survey	119
4.4.1 Individual Characteristics	119
4.4.2 Household Characteristics	120
4.4.3 Household Perceptions of Risks and AC Benefits	124
4.4.4 Household Participation in AC Services	127
4.5 Chapter Summary	127
 Chapter 5 Determinants of Households Participation in AC Credit and non-Credit Support Services.....	 130
5.1 Model Specification	130
5.1.1 Empirical Model	130
5.1.2 Estimations Diagnosis	140
5.2 Results and Discussion	142
5.2.1 Determinants of Participation in ACs.....	142
5.2.2 AC Credit Determinants	146
5.2.3 Determinants of Input Marketing Services.....	150
5.2.4 Determinants of Output Marketing Services	152
5.2.5 Determinants of Participation in AC Agricultural Extension Services.....	157
5.3 Chapter Summary	160
 Chapter 6 Effects of Agricultural Cooperative Services on Household Welfare	 163
6.1 Empirical Model	163
6.2 Tests for Exclusion Restriction	167
6.3 Result and Discussion.....	169
6.3.1 Determinants of Household Participation in Agricultural Cooperative Services.....	169
6.3.2 Effect of Agricultural Cooperative Services on Household Economic Welfare.....	174
6.3.3 Effect of Agricultural Cooperative Services on Household Social Welfare	188
6.4 Chapter Summary	207
 Chapter 7 Conclusion	 209
7.1 Reseach Background and Methodology	209
7.2 Major Findings	211
7.2.1 Determinants of AC Service Participation.....	212
7.2.2 Effects of Agricultural Cooperative Services on Household Welfare.....	215
7.3 Implications.....	216

7.3.1	Academic Implications	216
7.3.2	Policy Implications	217
7.4	Limitations and Future Research	224
	References	226
	Appendices	248
	Appendix A : Determinants of AC Participation.....	249
A.1	Reliability Test of Risk Factors and AC Benefit Expectation.....	249
A.2	Distribution of Participation Level and log Participation Level.....	250
A.3	Results of Endogeneity Problem for AC Participation and AC Credit Participation.....	251
A.4	Result of a Valid Instrumental Variable for AC Credit Model (Heckman Selection Model).	255
A.5	Result of a Valid Instrumental Variable for AC Input Marketing Model (Heckman Selection Model).....	256
A.6	Result of a Valid Instrumental Variable for AC Output Marketing Model (Heckman Selection Model).....	257
A.7	Heteroskedasticity Test Results	258
	Appendix B : Effects of AC Service Participation.....	259
B.1	Distribution of Household Welfare Indicators	259
B.2	Result of a Valid Instrumental Variable for Household Income Model	261
B.3	Result of a Valid Instrumental Variable for Farm Income Model	263
B.4	Result of a Valid Instrumental Variable for Household Consumption Model	265
B.5	Result of a Valid Instrumental Variable for Educational Expenditure Model.....	267
B.6	Result of a Valid Instrumental Variable for Health Affordability Model.....	269
B.7	Result of a Valid Instrumental Variable for School Enrolment Model.....	271
B.8	Result of a Valid Instrumental Variable for Adoption of Improved Farm Technologies and Practice Model	273
B.9	Result of a Valid Instrumental Variable for Household Health Accessibility Model.....	275
	Appendix C : Distribution and Mean Difference Test of Samples	277
C.1	Distribution of Users and Non-Users by AC service Type	277
C.2	Result of the Mean Difference Test of Household Income between Paddy and Non-Paddy Farmer Groups	278
C.3	Result of the Mean difference Test of Farm Income between Paddy and Non-Paddy Farmer Groups.....	278
C.4	Distribution of Average Household and Farm Income by Farm Type.....	279
	Appendix D : Survey Questionnaire	280

List of Tables

Table 1.1	Business Volumes of Agricultural Cooperatives in Thailand (2005-2014).....	9
Table 1.2	Performance of Agricultural Cooperatives and Member Participation Numbers, 2013 (By Type of Cooperative)	9
Table 2.1	Number of Agricultural Cooperatives and Members, 2014 (by Type)	23
Table 2.2	Business Volumes of Agricultural Cooperatives in Thailand, 2014 (Type of Cooperatives).....	26
Table 2.3	Volume of Sales of Input and Machinery by Agricultural Cooperatives in Thailand, 2013-2014.....	26
Table 2.4	Percentage of Rural Household Borrowing, 2008 and 2014 (Type of Credit Provider)	35
Table 2.5	Outstanding Debt of Farm Households in Thailand (1999-2012).....	35
Table 2.6	Number of Debt-Holding Households in the Agricultural Sector in Thailand (Source of Loan, 2013)	37
Table 2.7	Credit Outstanding Provided by Agricultural Cooperatives (2005-2014) (Credit Type)	37
Table 2.8	Share of Cooperative Marketed Agricultural Products to Domestic Agricultural Product Values in Thailand, 2005-2014.....	38
Table 2.9	Volume of Agricultural Products Traded through Agricultural Cooperatives in Thailand, 2007-2014	38
Table 3.1	Determinants of Credit Participation.....	63
Table 3.2	Determinants of Marketing Service Participation	75
Table 4.1	Economic and Social Indicators	105
Table 4.2	Number of Agricultural Cooperatives and Members in the Nakhonratchasima Province in 2016 by District.....	115
Table 4.3	Number of Households in the Nakhonratchasima Province in 2016 by Study Sites ..	118
Table 4.4	Individual Characteristics.....	121
Table 4.5	Household Characteristics	122
Table 4.6	Household Perceptions of Risk	125
Table 4.7	Household Perceptions of AC Performance	126
Table 4.8	AC Members' Participation in AC Services.....	128
Table 4.9	AC Service Attribute	129
Table 5.1	Determinants of Participation in ACs and AC Services	133
Table 5.2	Determinants of Participation in AC Membership and Marginal Effects	143
Table 5.3	Determinants of AC Credit Participation using the Heckman Two-Step Method	148
Table 5.4	Determinants of AC Input Marketing Participation using the Heckman Two-Step Method	153
Table 5.5	Determinants of AC Output Marketing Participation using the Heckman Two-Step Method	155
Table 5.6	Determinants of Participation in AC Agricultural Extension Services and Marginal Effects	159
Table 6.1	Effects of AC Credit and AC Marketing Service Participation on Household Income using the Endogenous Switching Model (ESR)	175
Table 6.2	Effects of AC Credit and AC Marketing Service Participation on Farm Income using the Endogenous Switching Model (ESR)	180
Table 6.3	Effects of AC Credit and AC Marketing Service Participation on Consumption Expenditure using the Endogenous Switching Model (ESR).....	184
Table 6.4	Effects of AC Service Participation on Household Economic Welfare.....	187
Table 6.5	Effects of AC Credit and AC Marketing Service Participation on Educational Expenditure using the Endogenous Switching Model (ESR).....	190
Table 6.6	Effects of AC Credit and AC Marketing Service Participation on School Enrolment using the Endogenous Switching Probit Model (ESP).....	192

Table 6.7	Effects of AC Credit and AC Marketing Service Participation on Adoption of Improved Farm Technologies and Practices using the Endogenous Switching Probit Model (ESP)	196
Table 6.8	Effects of AC Credit and AC Marketing Service Participation on Health Affordability using the Endogenous Switching Regression Model (ESR)	200
Table 6.9	Effects of AC Credit and AC Marketing Service Participation on Health Access Improvement using the Endogenous Switching Probit Model (ESP)	202
Table 6.10	Effects of AC Service Participation on Household Social Welfare	204
Table 6.11	Effects of AC Service Participation on Household Social Welfare	205

List of Figures

Figure 1.1	Number of the Poor	1
Figure 1.2	Proportion of the Poor	1
Figure 1.3	Rural Versus Urban Poor in Thailand	5
Figure 1.4	Number of Agricultural Cooperatives and Members in Thailand (2006-2015).....	7
Figure 2.1	Evolution of Thai Cooperatives.....	21
Figure 2.2	Agricultural Cooperative Structure in Thailand	23
Figure 2.3	Business Volumes of Agricultural Cooperatives in Thailand (2005-2014), (By Service)	23
Figure 2.4	Numbers of Indebted Farm Households in Thailand, by purpose (2013)	36
Figure 3.1	Presence of Credit Rationing	51
Figure 4.1	Effect of Agricultural Cooperative Participation.....	103
Figure 4.2	Proposed Framework for Sampling and Realization	118

Abbreviations

MDGs	Millennium Development Goals
ACs	Agricultural Cooperatives
MIF	Microfinance institution
OPPAZ	Organic Producers and Processors Association of Zambia
KAC	Khao Kitchakood Agricultural Cooperative
PFC	Phan Fisheries Cooperative
GNC	Green Net Cooperative
ICA	International Cooperative Alliance
CLT	Cooperative League of Thailand
CPD	Cooperative Promotion Department
CWG	Cooperative Women's Group
TABCO	Thai Agri-Business Co., Ltd
JAs	Japanese Agricultural Cooperatives
BAAC	Bank for Agriculture and Agricultural Cooperatives
PCG	Production Credit Group
P4P	Purchase for Progress
IMR	Inverse Mill's Ratio
EEVs	Endogenous Explanatory Variables
2SLS	Two-Stage Least Squares
G2SP	Generalized Two-Stage Simultaneous Probit
2SCML	Two-Stage Conditional Maximum Likelihood
UIS	UNESCO Institute for Statistics
ATT	Average Treatment Effect on the Treated
ATU	Average Treatment Effect on the Untreated
TT	Effect of Treatment Effect on Treated
TU	Effect of Treatment Effect on Untreated
OLS	Ordinary Least Square
PSM	Propensity Score Matching
ESR	Endogenous Switching Regression
RBP	Recursive Bivariate Probit
ESP	Endogenous Switching Probit
FIML	Full Information Maximum Likelihood
IV	Instrumental Variable
IHS	Inverse Hyperbolic Sine Transformation
TH	Transition Heterogeneity

Chapter 1

Introduction

1.1 Introduction

At the end of the Millennium Development Goals (MDGs) period in 2015, the World Bank reported that the world had made significant progress in its alleviation of poverty (see Figures 1.1 and 1.2). The percentage of global poverty has declined continuously from 1,897 million people (35.9% of the global population) in 1990 to about 731 million people (9.9% of the global population) in 2015. However, the portion of people living on less than \$1.90¹ a day still remains unacceptably high (World Bank, 2016a). The largest group of poor live in rural areas and work in the agricultural sector. This accounts for 70% of the 1.4 billion extremely poor people in developing countries (Heinemann & Shepherd, 2011).

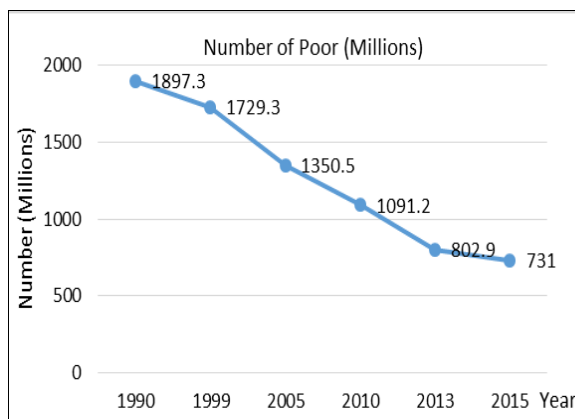


Figure 1.1 Number of the Poor
Source: World Bank, 2019

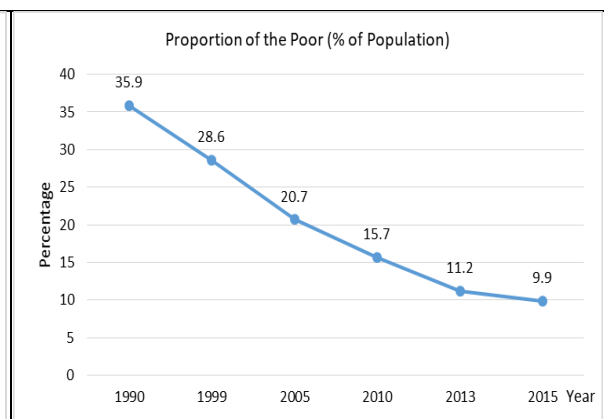


Figure 1.2 Proportion of the Poor

Rural finance plays a crucial role in well-being of rural people. Agricultural production is a long-term investment. In addition, rural households face natural uncertainty (droughts and floods) and market volatility in terms of their products and prices. In these conditions, less revenue and/or more expenditure negatively impact rural households' welfare. Rural finance enables individuals to invest more in economic activities and ultimately smooth their consumption (Reed, 2011). As a result of increased investment, rural people can improve their productivity, asset formation, and generate more income. Increasing income enhances the opportunity for the poor to attain food and services. Eventually, they can improve their family's livelihood by obtaining better nutrition, health care,

¹ The World Bank (2015) defines poverty as living below US \$1.90 a day (the national poverty line).

education and potentially escape from poverty. For example, a low-income household in Bangladesh can increase their income due to credit provided by the Grameen Bank (Islam, 2008).

The borrowers spend credit on income generating activities and human capital development, such as their children education and family members' health. As a consequence, their incomes and well-being increases.

Unfortunately, a lack of access to traditional financial institutions is still a barrier for many rural populations. Mainstream banks ignore the poor in rural areas because of high transaction costs, risky activities, a lack of collateral, and poor financial records. The poor only request a small amount of credit for their small scale farms or agriculture-related activities. Moreover, there is a high cost of serving rural households due to living in low population, low density areas, and poor infrastructure. It costs too much for banks to set up the loans and that is why banks are not interested in having them as customers. Farmers' incomes are unstable since their crop yields are seasonal and prices are volatile. Moreover, serving the rural credit market is complicated based on the types of crops that farmers grow. These factors means that formal financial institutions are reluctant to serve rural customers (Charitonenko & Campion, 2003). As a result of a lack of access to formal credit, rural people turn to informal agents who charge high interest rates and offer limited financial services. The high cost of informal credit impedes production investment, contributing little to income generation. Thus low income households become trapped in a vicious cycle of poverty (Charitonenko & Campion, 2003).

Agricultural Cooperatives (ACs), one type of microfinance institution (MFI), is a viable option for rural households to combat poverty (Food and Agriculture Organization of the United Nations, 2012a). ACs have more than 800 million members and provide 100 million jobs worldwide, which is 20% greater than multinational enterprises (Food and Agriculture Organization of the United Nations, 2011).

A cooperative is defined as a group of people working together to achieve a common purpose for its members through sharing ownership and making democratic decisions (Dardak, 2015). A

Cooperative works on cooperative principles; they are member-owned, member-run and member-serving (Dardak, 2015). ACs or farmers' cooperatives are groups of farmers who work together for the common good. ACs aim to maximize members' benefits. ACs were established because farmers were not able to access high quality inputs at reasonable prices. In addition, farmers face many obstacles such as having to use middlemen to sell their products, and a lack of transportation and infrastructure to reach markets (Food and Agriculture Organization of the United Nations, 2012a). In addition to credit, ACs provide access to natural resources, access to input and output markets, various technologies, information and training. Members gain bargaining power and receive better prices. Moreover, ACs increase small farmers' ability by providing information and knowledge that

enables them to apply innovation and technology in their production. This includes adapting to a changing market. With the support of these non-credit services, farmers can improve their production and market power; as a result, their income increases contributing to improvement in their welfare and a reduction in their levels of poverty. For example, the goal of goat ACs in Nepal is to develop markets for high quality breeding goats. Under this program, smallholder farmers can produce surpluses, gain market access and improve their incomes (Food and Agriculture Organization of the United Nations, 2011).

There are two types of ACs; agricultural production cooperatives and agricultural service cooperatives (Smith, 2011). Members of agricultural production cooperatives share production resources, such as land and machinery. Agricultural service cooperatives, which are the major form of AC, provide diverse services to members. The agricultural service cooperatives are divided into supply cooperatives which provide members with inputs for farm production (seeds, fertilizers and machinery services), and marketing cooperatives, which include transportation, packing, distribution, and marketing for agricultural products.

ACs provide credit and non-credit support services such as purchasing, marketing and agricultural extension services to their members. ACs are involved in many activities, however, each AC focuses on different activities which are appropriate for their members' needs and problems. For example, coffee cooperatives in El Salvador and milk cooperatives in India focus on marketing activities in order to solve market access and middlemen problems for their members (Ruete, 2014). Coffee cooperatives in El Salvador encourage members to sell their coffee through cooperatives because they provide economic benefits. Indian milk cooperatives remove the role of middlemen by connecting producers directly to consumers. Danish cooperatives and the Organic Producers and Processors Association of Zambia (OPPAZ) help small farmers achieve higher product prices by improving the quality and volume of products (Ruete, 2014). OPPAZ focuses on agricultural extension services and purchasing activities by providing their members with innovative equipment and technologies. Using new technologies, members are able to improve the quality and quantity of their products leading to higher prices and revenues. These cooperatives also offer non-credit support services to improve their effectiveness.

Funding and member participation are key factors in AC success (Ruete, 2014). Funding scarcity is a result of a lack of member participation in ACs. The main sources of funding are internal funds such as equity, savings, and profits from members' businesses. Therefore the amount of funding depends on business volume, which members operate through ACs. In order to resolve funding problems, some Asian countries such as China, Indonesia and Malaysia, use business partners. In these countries, ACs operate in cooperation with the government. ACs are used as a channel to implement

the government's development plan at a community level. In order to fulfil its development plan, the government typically subsidises financial and human capital and provides ACs with staff members, agricultural funding and marketing. For example, the Indonesian and Malaysian governments provide funding to the ACs and in turn, the ACs offer credit and input such as fertilizers to its members (Ahmad, 2006; Suradisastra, 2006). In addition, the Indonesian government purchases all farming products from the country's ACs and offers guaranteed prices. Similarly, the Malaysian government has established specific government organizations to support agricultural development and provide markets for farm products. Thus, the government can control the type and quantity of farm production. Due to government support, many farmers choose to participate in ACs since these support services improve members' production and opportunities to access markets, which ultimately increase their income (Ahmad, 2006; Suradisastra, 2006).

Another successful example of AC partnership can be found in China. The Chinese government aims to improve the quality of farm production and control the quantity of farm products. The Chinese government has negotiated a contract with farmers, using ACs as an implementing channel. Using farming contracts, the government can control quantity and quality of farm products. The government provides credit and controls what farmers produce and how much farm inputs (e.g. fertilizers and pesticides) they are able to use through the ACs (Hoken & Su, 2015; Ito, Bao, & Su, 2012).

Proper financing is the crucial factor which influences AC success (Williams, 2007). By partnering with the government, ACs have sufficient cash flow to function effectively. ACs that operate without a partner have to finance themselves by borrowing from banks, providing savings, and issuing shares. While they have management independence, their funding is limited and insufficient to support all of their members' needs. For instance, both Thai and Filipino ACs operate without partners and thus often face a lack of funding and members' participation (Araullo, 2006; Thuvachote, 2007). Most of the ACs are either too small or still immature. Their main funding sources are equity, borrowing, and savings. Thus, they have limited financial resources to support their services, especially in the case of supporting all services simultaneously. Funding scarcity impedes AC effectiveness. Due to ACs' inefficiency, farmers are not interested in becoming members or participating in their businesses.

1.2 Rural Poverty and Agricultural Cooperatives in Thailand

Thailand population structure is similar to many other developing countries. The major proportion of the total population (about 84%) live in rural areas (Cooperative Promotion Department, 2014). More than one third, or 35% of the total rural population, work in the agricultural sector and about 31% of the total rural households are freelancers or unemployed (Community Development Department, 2014). These rural households have limited resources, low levels of education and

capital. Therefore, they have low abilities to mitigate risk, manage their resources and cash flow when unexpected crises happen. These factors mean that they are likely to remain in poverty. In 2013, approximately 4.9 million Thais or 66.6% of the poor live in rural areas (Office of the National Economic and Social Development Council, 2015). Figure 1.3 shows that rural poverty is far higher compared to urban poverty.

ACs assist small farmers who are disadvantaged in the recently commercialized economy. With regards to self-sufficient development, ACs have two important roles; providing financial capital and production assistance to rural households. ACs deliver credit and non-credit support programs to support farmers' production by connecting them to input and output markets and other farmers. Integrating all product support enables farmers to generate income and improve their livelihoods which results in poverty reduction (Food and Agriculture Organization of the United Nation, 2012b).

The first AC, Wat Chan Cooperative Unlimited Liability, was established by the government in Phitsanulok, Thailand on the 26th of February 1916 (Cooperative League of Thailand, 2012). This was because Thai farmers faced sudden changes in the economy and natural disasters such as droughts and floods. When Thailand began to trade with foreign countries in 1914, this led to a change from a self-sufficient economy to one based on trade (Tanrattaphong, 2015). However, the majority of farmers were unable to compete in the commercialized economy due to the nature of their farming practices (they were small scale farmers) and financial constraints. This change led them to increase their debt. Many ultimately lost their land (Cooperative League of Thailand, 2012). The Wat Chan Cooperative Unlimited Liability provided farmers with credit. Their primary aim was to reduce small farmers' debts and improve their livelihoods.

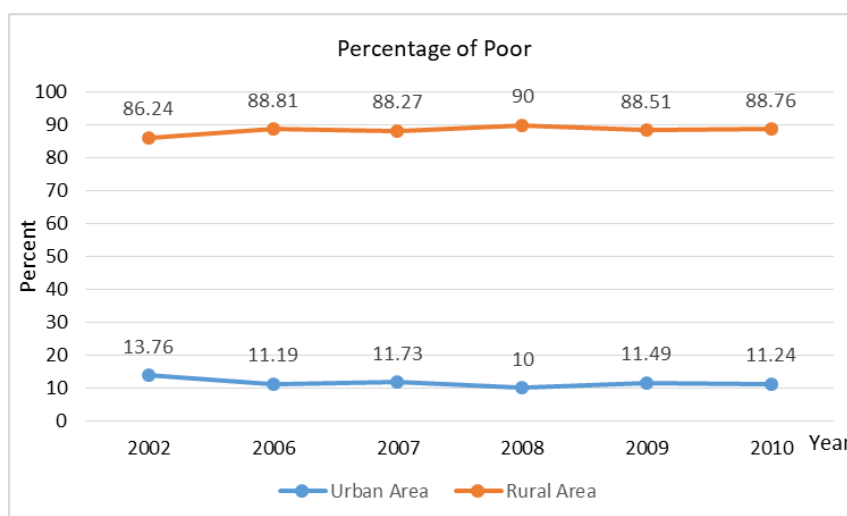


Figure 1.3 Rural Versus Urban Poor in Thailand

At present, ACs operate under the Cooperative Societies Act, B.E. 2542. Their primary objective is to provide support for all areas of agricultural production, including marketing development, and ultimately to improve members' well-being via increased income (Registrar and Law Office, 2016). ACs membership consists of common members and ordinary members. Both members live in the community, but common members are those who perform agricultural activities while ordinary members work in any occupation. Only one member of each household can be an AC member. Most ACs members are small and medium farmers, located in rural areas, with restricted access to financial and product markets (Thuvachote, 2011). ACs play an important role in improving agricultural production and resolving financial capital scarcity and market accessibility for their members.

Thai ACs are unique and different from other ACs worldwide. Thai ACs combine supply cooperatives with marketing cooperatives in order to serve the whole supply chain of agricultural production. To meet members' needs, Thai ACs provide six services to members; these are credit, savings and deposits, purchasing, marketing, food processing, and agricultural extension services (Thuvachote, 2007). For financial services, ACs provide credit and saving facilities. ACs provide farmers with loans for both production and consumption purposes such as buying seeds, fertilizers, and machinery, along with purchasing or improving land. In terms of loan duration, loans are divided into short-term, medium-term, and long-term for urgent need, cultivation investment, and asset investment, respectively (Thuvachote, 2007). ACs are popular choices for farmers because borrowing from them entails several advantages such as low interest rates and flexible repayment schedules compared with bank loans. The annual interest rates charged by ACs is around 6% (Ministry of Agriculture Forestry and Fisheries, 2005). This rate is slightly higher than the BAAC rate but it is less than commercial bank rates (Preedasak & NaRanong, 2001). AC loan terms and conditions are designed to match the farmer's cash flow. In order to reduce members' vulnerability, ACs encourage members to save by offering two types of savings; savings and fixed term deposits (Cooperative Promotion Department, 2015).

Besides credit and savings, Thai ACs also provide non-credit support services which cover the overall supply chain. Non-credit support services can reinforce credit effectiveness and enable farming households to improve their welfare. For production, AC members are served by purchasing and agricultural extension services to develop their productivity and access input markets. Offering opportunities for purchasing agricultural goods is an important service for members since it enables them to gain access to good quality agricultural machinery and materials at lower prices. ACs sell agricultural supplies and consumer goods in order to reduce members' costs and ensure that members can access input at reasonable prices. Agricultural extension services promote farmers' productivity and reduce costs, including land development, irrigation and demonstration farms. The

agricultural extension service is funded through sharing expenses among AC members (Cooperative Promotion Department, 2015).

In terms of distribution, ACs also offer marketing and food processing services to enable members access to product markets and also add value to their agriculture products. ACs often collect and sell members' products directly to the markets at market prices with fair weights and measurements. The marketing service is crucial since ACs are able to bypass the middleman (something which individual farmers are not able to do) (Preedasak & NaRanong, 2001). Both practices increase farmers' bargaining power. Moreover, members can earn more income via food processing activities.

Overall, ACs in Thailand promotes a certain level of business growth. ACs are successful in terms of the number of members and business volume. The number of AC members has been steadily increasing for the past ten years (see Figure 1.4). Although AC branches have decreased (see Figure 1.4), they continue to serve rural low-income people throughout the country; in 2014 there were 4,317 institutions (Cooperative Auditing Department, 2015; Lewis, Tambunlertchai, Suesuwan, Adair, & Hickson, 2013). The success of ACs in Thailand is demonstrated by the total volume of business. Total business volume has risen gradually since 2005 to 2013, with the exception of 2014. In 2014, the growth rate was negative, at -4% (see Table 1.1). This was due to a decline in the business volume of AC marketing services.

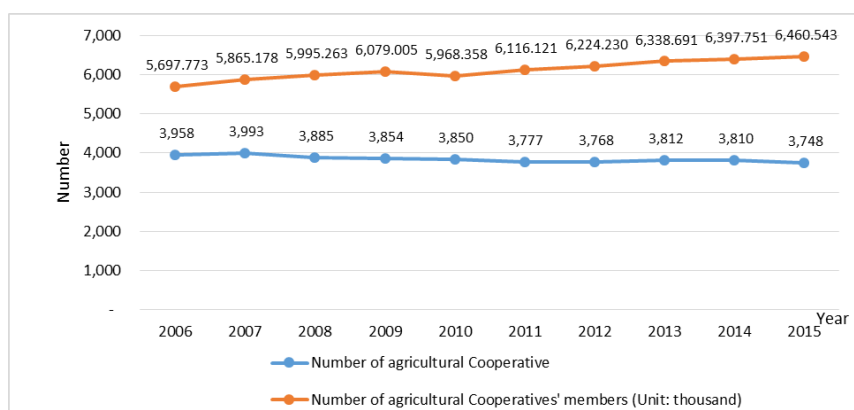


Figure 1.4 Number of Agricultural Cooperatives and Members in Thailand (2006-2015)

Source: Cooperative Promotion Department, 2015a

Thai ACs have been in existence for more than 100 years, but most have been unable to achieve self-sufficiency. This is because they face problems such as low member participation, ineffective operations, and vague development plans (Tanrattanaphong, 2015). Only a few ACs are successful, such as the Khao Kitchakood Agricultural Cooperative (KAC), Phan Fisheries Cooperative (PFC), Green Net Cooperative (GNC), and Tha-Yang Cooperative Ltd., (Tanrattanaphong, 2015). Their achievements are the result of success in product quality improvement, marketing management, and high member participation in AC services. They solve excessive supply problems and low prices by

improving the quality of members' products and/or establish markets for high quality products. These strategies have been successful; members are willing to join non-credit AC support services and learn new techniques to improve their production. As a result, members' incomes and well-being increases.

While ACs succeed in members and business growth, they are not always able to fulfil their core mission (which is to improve rural households' economic and social welfare). Thai ACs face many problems. One of the most serious problems for Thai ACs is low member participation in non-credit support services, especially in marketing and food processing. Only 2.40 and 8.35% of AC members join marketing and processing programs respectively (see Table 1.2). Limited member participation in marketing is a serious problem, as the more members who participate the greater ACs' bargaining power is. Bargaining power enables small farmers to compete with private traders and obtain higher prices for their products. Low participation in marketing services means that members lose opportunities to increase their income. The AC purchasing program exhibited 34.20% participation in 2013 (see Table 1.2). The purchasing program provides goods for consumption and production materials which meet members' needs and are essential to agricultural production and consumption (Preedasak, 1998). In addition, buying input and goods from ACs provides members with many advantages compared to buying from merchants; these include paying fair prices, buying on installment plans with low interest rates, good quality products, and saving transaction costs.

Strong member participation in AC services is a crucial factor which affects the cooperative's and members' benefits (Ruede, 2014; Williams, 2007). As noted earlier, ACs are operated by members and their capital and cash flow depend on members' transactions. If there is low member participation or trade through ACs, they will not have enough capital to survive and to help poor rural households. Low member participation in Thai ACs should be analysed in order to ensure that they function more effectively and ultimately alleviate poverty.

Table 1.1 Business Volumes of Agricultural Cooperatives in Thailand (2005-2014)

Business/Year	Deposit	Credit	Purchasing	Marketing	Food Processing	Agricultural Services	Unit: Million Baht	
							Total	Growth Rate (%)
2005	28,717.57	32,026.95	24,754.76	-	-	294.55	85,793.83	
2006	30,554.48	33,423.12	30,061.45	-	-	255.98	94,295.03	9.91
2007	33,224.46	37,312.66	35,050.57	-	10,879.83	296.62	116,764.14	23.83
2008	36,580.17	40,369.96	39,814.56	-	10,811.06	294.78	127,870.53	9.51
2009	43,572.83	45,366.93	50,084.34	45,774.64	1,522.94	311.60	186,633.28	45.95
2010	50,540.69	51,826.41	44,835.00	55,676.12	12,142.79	332.08	215,353.09	15.39
2011	57,006.30	58,467.20	48,137.24	73,517.11	18,645.33	380.29	256,153.47	18.95
2012	63,837.06	67,003.72	55,533.50	85,266.74	18,269.59	439.58	290,350.19	13.35
2013	71,855.54	77,498.44	64,670.62	74,150.81	18,045.82	450.97	306,672.20	5.62
2014	68,970.87	81,893.75	68,796.48	58,586.75	15,700.91	431.88	294,380.64	- 4.01

Source: Cooperative Auditing Department, 2014

Table 1.2 Performance of Agricultural Cooperatives and Member Participation Numbers, 2013 (By Type of Cooperative)

Type of Business	Business Volume		Members' patronage	
	Volume (Million Baht)	Percentage	Number	Percentage Compared with Total Members
Depositing	69,174.51	20.45	1,291,774	20.19
Credit	76,936.73	22.74	1,034,780	16.17
Purchasing	71,413.90	21.11	2,188,324	34.20
Marketing	92,317.17	27.29	153,288	2.40
Processing	25,199.55	7.45	534,517	8.35
Agricultural Extension Service	3,277.72	0.97	130,847	2.05
Others	0.00	0	26,766	0.42
Total	338,319.58	100	5,360,296	83.78

Source: Cooperative Auditing Department, 2014

1.3 Research Problems and Questions

In recent years, household debt in Thailand has skyrocketed. It is approximately 83% of Thailand's gross domestic product (Thailand Development Research Institution, 2015) and about 48.84% of total household debt is in the agricultural sector (Bunthong, 2014). One solution suggests that credit provisions enable households to improve their economic conditions through investment in income generating activities (Islam, 2008; Kondo, Orbeta, Dingcong, & Infantado, 2008; Li, Gan, & Hu, 2011b). However, the literature shows that only providing credit (without other services) does not lead to a reduction in debt and/or poverty (Anuchitworawong, 2007; Poapongsakorn, 2014). Thai households remain in debt because they are unable to utilize the loans effectively or to generate income (Thailand Development Research Institution, 2015).

Several studies have found that microcredit alone is insufficient for promoting rural household welfare because borrowers do not have the capabilities to invest the loans in productive activities. They are more likely to spend it in consumption than invest in activities that will generate income (Ashakul & Chandoevlwit, 2007; Boonperm, Haughton, & Khandker, 2013; Chandoevlwit & Ashakul, 2008). Borrowers cannot generate sufficient income to enable them to repay the loans and thus they are unable to improve their welfare. Moreover, borrowers often spend most of their loans in interest payments and repaying debt to other lenders (Ashakul & Chandoevlwit, 2007; Boonperm et al., 2013).

In order to improve the effectiveness of credit, some researchers suggest that non-credit support services, such as purchasing, marketing, and agricultural extension services, should be provided simultaneously with credit (Chowdhury, 2009; Hulme & Mosley, 1996). These non-credit support services are important to enable borrowers to invest in income generating activities. Agricultural extension services are necessary to develop borrowers' abilities and improve their productivity. Moreover, producers have more opportunities to access markets due to AC purchasing and marketing services.

Examples of successful financial institutions providing non-financial services are coffee cooperatives in Ethiopia and financial institutions in Sri Lanka. In Ethiopia, small farmers have been confronted with several problems, such as unstable coffee prices, high risk investments, low returns, and poor infrastructure. In order to help them to overcome such obstacles, coffee cooperatives provide credit and saving services, coffee marketing, and distributing or selling inputs to members. As a result of marketing and distributing services, Ethiopian farmers who participate in coffee cooperatives have gained access to markets and received fairer prices for their product. Coffee cooperative members earned more income by 26% compared to not being a member and improved the lives of 15 million

small farmers in 2010 (Mojo, Fischer, & Degefa, 2015b). Similarly, two financial institutions, TCCSs and SEEDS, in Sri Lanka provide both financial and non-financial services. In terms of non-financial services, these cooperatives provide skill training, marketing and purchasing services, business development, and educational programs. With the support of non-financial services, borrowers learn to use loans productively. One study reveals that households that use non-financial services earn more than those who do not. The non-financial services increased monthly income by Rs. 1,312 per household (Herath, Gunaratne, & Sanderatne, 2013).

In Thailand, ACs provide non-credit support services. Thai ACs offer non-credit support services to support members' agricultural production and marketing for generating income and improving well-being. ACs have been promoted by the Thai government as the main financial intermediaries for rural people to enhance their access to financial capital (Banking with the Poor Network, & Foundation for Development Cooperation, 2010; Lewis et al., 2013).

Despite Thai ACs providing credit and non-credit support programs to help rural households, the number of poor in rural areas have not reduced as forecast (see Figure 1.3). One possible cause impeding AC effectiveness in poverty reduction is low participation rates. Only 18.59% of the total Thai rural population are AC members (Cooperative Promotion Department, 2014; World Bank, 2016b). Another possible reason is that AC members do not use integrated services and therefore ACs cannot work as effectively to support the whole supply chain of members' production. Since most rural people have a low income and a poor standard of living, smooth consumption is the rural poor's first priority (Chanchengpanich, 2015). Thus, many AC members prefer to borrow and to buy inputs at low prices instead of using existing non-credit services such as marketing, processing, and agricultural extension services (Chiengkul, 2015).

There are limited studies which examine how to improve rural household welfare through credit and non-credit support services. Previous studies on credit impact evaluation in Thailand have paid attention on the impact of credit product provided by other financial institutions such as the VF, BAAC, and informal MFIs. For example, Charitonenko and Campion (2003), Coleman (1999, 2006), and Vijitsrikamol, Bunyasiri, Sirijinda, and Kitchaicharoen (2013) have all studied the impact of microcredit on borrowers' welfare in Thailand. Moreover, there are many studies which focus on the impact of microcredit offered by the Village Fund (Boonperm et al., 2013; Chandoevwit & Ashakul, 2008; Kaboski & Townsend, 2012). In terms of the impact of ACs, there is only one study which describes the role of cooperatives in poverty reduction in Thailand. Thuvachote (2011) uses descriptive analysis to investigate the role of ACs on rural poor households. Our study will bridge the gap in the literature by focusing on rural household welfare improvement through AC credit and non-credit support services. The findings of our study will enable practitioners and policymakers to have a

clearer understanding of the role of ACs on rural household welfare, rural household needs, and the effects of ACs on rural household welfare. As a result, policymakers and practitioners will be able to develop better AC credit and non-credit support services to meet rural household needs and work more effectively to improve rural household welfare.

The purpose of our study is firstly to evaluate the effect of AC credit and non-credit support programs on rural household welfare and secondly, to examine the determinants of rural households' participation in AC credit and non-credit support programs. Our study is guided by four research questions:

Research Question 1. How can ACs help Thai rural households to improve their economic and social welfare?

Research Question 2. What are the effects of AC credit provisions on Thai rural households' economic and social welfare?

Research Question 3. What are the effects of AC non-credit support programs on Thai rural households' economic and social welfare?

Research Question 4. In what ways can ACs improve both credit and non-credit support services in order to meet members' needs?

1.4 Research Objectives

The main objective of the current study is to examine the effects of ACs' credit and non-credit support programs on Thai rural household's economic and social welfare. The objectives are:

1. to investigate the role of ACs in improving Thai rural households' economic and social welfare;

2. to investigate the determinants of rural households' participations in AC credit and non-credit support services;

3. to evaluate the effects of AC credit provisions on Thai rural households' economic and social welfare;

4. to examine the effects of AC non-credit support programs on Thai rural households' economic and social welfare;

1.5 Contribution of the Study

While the Thai government has noted the central role of ACs in improving rural households' economic and social welfare, there are limited studies which focus on how to improve rural household welfare through their services and programs. Most prior studies on impact assessment in Thailand focus on other MFIs such as informal MFIs and village funds. Our study will bridge the gaps in previous studies by focusing on improving rural household welfare via ACs in both credit and non-credit support services. It will thereby help practitioners and policymakers to better understand the effects of ACs on rural household welfare. Moreover, the study will provide significant information for practitioners and policymakers regarding the different types of products and services that work best for the target customers. Both policymakers and the ACs administrators can apply the findings from our study to improve rural household welfare and to increase operational efficiency.

Moreover, most prior studies tend to examine the impact of AC participation on household economic welfare using income, consumption and assets as indicators of poverty alleviation. Our research employs social effects such as children's education levels and access to healthcare services, to measure effects of rural households' participation in ACs' credit and non-credit support services (marketing and agricultural extension services). Using social effects to measure the impact of participation in ACs' credit and non-credit support will provide a different picture of the effect of AC participation on rural household welfare. By doing this, our study will contribute to the growing body of literature in this field.

1.6 Structure of the Thesis

The remainder of this thesis is organized as follow. Chapter 2 provides an overview of the ACs currently operating in Thailand. It defines the cooperative concept, outlines agricultural cooperatives in Thailand, and explores the role of Thai ACs in poverty reduction. Chapter 3 reviews the literature on the demand theory focusing on credit and marketing services and theory of credit rationing. It also includes an overview of determinants of households' decisions to participate in credit and non-credit support services and the effects of AC participation on households' economic and social welfare. Chapter 4 presents the research methodology and profiles of the sampled households in the survey. Chapters 5 and 6 present results and discussion. While Chapter 5 discusses the determinants of participation in ACs, AC credit, and non-credit support services, Chapter 6 evaluates the effects of participation in AC credit and non-credit support services on household economic and social welfare. To mitigate selection bias, two models are applied to assess the effects of AC service participation. Finally, Chapter 7, the final chapter, presents the conclusion, policy implications, limitations of study, and topics for future research.

Chapter 2

Overview of Agricultural Cooperatives in Thailand

This chapter provides an overview of the cooperative concept, ACs in Thailand, and the role of ACs in the Thai economy, particularly in relation to poverty reduction. This chapter is divided into four sections. Section 2.1 describes key cooperative principles and provides an overview of the different types of cooperatives. Section 2.2 focuses on Thai ACs, including their evolution, current status, as well as challenges and innovations. Section 2.3 examines the role of ACs in rural finance and the agricultural market. Lastly, section 2.4 explains how ACs can assist rural households in poverty reduction in general, and concludes by explaining the situation in Thailand.

2.1 Cooperative Concept

2.1.1 Cooperative Definition and Principles

The definition of cooperatives varies greatly. According to the International Cooperative Alliance (ICA), a cooperative is “an autonomous association of persons united voluntarily to meet their common economic, social, and cultural needs and aspirations through jointly-owned and democratically-controlled enterprise” (Zeuli, Cropp, & Schaars, 2004, p.1). The United States Department of Agriculture (USDA, 1987) define cooperatives as, “a user owned, a user controlled business that distributes benefits on the base of use” (Zeuli et al., 2004, p.1). In the case of Thailand (according to the Cooperative Act, B.E. 2542), a cooperative is “a group of persons who jointly conduct affairs for socio-economic interests on the basis of self-help and mutual assistance and are required under this Act” (Thuvachote, 2007, p.4). Cooperatives can be defined by two characteristics. Firstly, cooperatives are voluntary organizations formed by persons to serve their socio-economic needs. Secondly, cooperatives are owned by their users, controlled by their users and the benefits should be distributed to those users (Zeuli et al., 2004).

Cooperatives follows seven basic principles, which are interpreted by ICA as follows (ICA, 2006, as cited in Tamirat, 2015; ICA, 1995, as cited in Tereda, 2011):

1. Voluntary and open membership.

Cooperatives are voluntary associations where every person can be member and use their services without discrimination, based on gender, social, and religion.

2. Democratic member control.

Cooperative members are able to democratically control, govern, and contribute to cooperative policies through voting. Every member is equal based on the one member one vote principle.

3. Member economic participation.

Cooperative members can participate in cooperative operations by contributing and controlling cooperative capital, engaging in cooperative businesses, and supporting cooperative activities. Members contribute to cooperative capital by investing in equity which is a condition of membership. Engaging in cooperative business is important to cooperatives' success (Mensah, Karantininis, Adegbedi, & Okello, 2012).

4. Autonomy and independence.

Cooperatives are self-governing and self-help organizations which are controlled by their members.

5. Education, training, and information.

Cooperatives provide knowledge to members, representatives, managers, and employees to develop the cooperative. The members, representatives, and employees can engage in education and training supported by the cooperative.

6. Cooperation among cooperatives.

In order to work efficiently, cooperatives should cooperate with local, national, and international cooperatives.

7. Concern for community.

Community development is one of the cooperative's goals. Therefore, the cooperative should be designed to ensure community sustainability.

Based on these principles, cooperatives differ from business organizations. Cooperatives belong to users or members. The users are able to make decisions through their votes and via representatives on the board of directors (Zeuli et al., 2004). In addition, members ought to share the benefits and costs, as well as the risk of running cooperative businesses (Zeuli et al., 2004).

2.1.2 Different Types of Cooperatives

Cooperatives may be classified into different groups, depending on different features: groups served, size, areas, functions, types of membership, as well as legal status and financial structures (Williamson, 1987). With respect to the groups served, cooperatives are divided into agricultural producer and consumer cooperatives. The most important agricultural producer cooperative is the AC. ACs are divided into two main types; agricultural production cooperatives and agricultural service cooperatives (Bernard, Spielman, Taffesse, & Gabre-madhin, 2010). Agricultural production cooperatives are collective production units whose members share capital and utilize resources together. Agricultural service cooperatives serve other functions such as marketing, supply, and

services. Consumer cooperatives are divided on the basis of products served, such as consumer goods, credit, health care, housing cooperatives, and mutual insurance companies (Williamson, 1987).

In terms of areas served, there are four types of cooperatives; local, regional, national, and international cooperatives. Local cooperatives are trading centre for members who are individuals. Regional cooperatives provide wholesaling and manufacturing services. Some special services that regional cooperatives cannot provide are served by national cooperatives. International cooperatives perform business on an international basis (Williamson, 1987).

ACs may also be grouped based on their functions, such as marketing, supply, and service cooperatives. Marketing cooperatives provide marketing services for members' farm products. Supply cooperatives offer farm materials and equipment, such as seeds, fertilizers, petroleum products, farm equipment, as well as food. Service cooperatives provide extension services to members at competitive prices, such as credit, electricity, telephone, insurance, and irrigation (Williamson, 1987).

In terms of member type, there are four types of cooperatives; local, federated, centralized, and mixed cooperatives. Members of local cooperatives are farmers, while local cooperatives are members of the federated cooperatives which control local cooperatives. Centralized cooperatives are similar to local cooperatives, except that they operate in large areas or across states. Mixed cooperatives serve both individual and local cooperatives (Williamson, 1987).

In terms of the financial structure criteria, cooperatives are divided into stock and non-stock cooperatives. They differ in terms of ownership. Ownership of stock cooperatives is stockholders' equity represented by a share of stock while ownership of non-stock cooperative is membership. Another criteria for group cooperatives is legal status; there are both incorporated and unincorporated cooperatives (Williamson, 1987).

2.2 Overview of Agricultural Cooperatives in Thailand

2.2.1 The Cooperative Movement in Thailand

In Thailand, cooperatives have been operating for 100 years. Cooperatives were initially developed to solve farmers' debt and a lack of capital lack for farm production (Pratuckchai & Patichol, 2016). The success of the first cooperative led to the establishment of other cooperatives. The cooperative evolution in Thailand can be divided into four eras; trial, adjustment, expansion, and improvement (Baumrungwong, 2001).

Trial Era (1916-1927)

The first cooperative was established in Thailand to resolve farmers' debt. Due to economic changes, from a subsistence economy to commercialization, demand for agricultural products, particularly rice, increased. Farmers needed more capital to expand their production. However, they lacked the finance to do so. The only available channel for borrowing was through informal lenders. Due to high interest rates and fluctuations in the prices and quantity of agricultural products, farmers could not guarantee enough income to meet loan repayments. As a result, they became indebted and often had their land confiscated as a result (Pratuckchai & Patichol, 2016).

In order to assist farmers, the government established village credit cooperatives. Since the cooperative concept was a new idea for Thai people, all of the cooperatives used a top-down approach. This model differs from those in other countries/regions, such as Europe and the US which were established and managed by the people (A bottom-up approach). The village credit cooperatives borrowed loans from the Siam Commercial Bank and lent credit to their members (Baumrungwong, 2001).

Adjustment Era (1928-1951)

This period represents the golden age for Thai cooperatives. Thanks to the success of the first cooperative, the government expanded cooperatives, both in terms of quantity and type. They established marketing cooperatives, land settlement cooperatives, and consumer cooperatives (Baumrungwong, 2001). All types of cooperatives established in this phase were designed to support farm production. In order to support their operation, the Thai government established the Bank for Cooperatives, with the capital from government in 1943. This was an important source of funds for these cooperatives.

At the provincial level, provincial cooperative banks were formed in the Chiang Mai and Uttaradit provinces in 1951 and 1952 (Baumrungwong, 2001). Provincial cooperative banks performed like commercial banks. They offered credit and deposit for cooperatives and individuals in the province. The provincial cooperative banks served members very well in terms meeting credit needs and obtaining surplus funds in deposit (Ratanamalai, 2001). It is almost certain that the provincial cooperative banks were the main funding source for cooperatives. They offered rural communities access to much needed finance.

During this period, the number of cooperatives increased dramatically; from 2,998 in 1941 to 10,811 in 1966. There were 22 different types of cooperative throughout Thailand (Pratuckchai & Patichol, 2016). However, the number of cooperatives grew too quickly and most of the cooperatives were small. The government was not able to support all of these small cooperatives and hence they were not able to be as effective as they could have been.

Expansion Era (1952-1971)

During this period, the government attempted to improve the efficiency of cooperatives. There were several policies implemented by the government to develop cooperatives. The government established the Cooperative League of Thailand (CLT) in 1968. CLT was a national cooperative and had 89 cooperatives (as members). CLT focused on activities which would improve ACs' performances (Baumrungwong, 2001).

During this period, the government introduced many new laws which affected cooperatives. Firstly, the government issued the Act of Commercial Bank in 1962 (Baumrungwong, 2001). This Act prohibited provincial cooperative banks from serving deposits current accounts. This limited the sources of fund for cooperatives. In addition, in 1968, village cooperatives were integrated into district cooperatives (Baumrungwong, 2001). However, this merger did not improve the efficiency of these cooperatives, since most of the district cooperatives were now made up of small and fragile cooperatives. Another act that considerably impacted on cooperatives was the Bank for Agriculture and Agricultural Cooperative Act of in 1966 (Baumrungwong, 2001). Under this Act, the provincial cooperative banks were cancelled. Although they are the main funding source of ACs, the Bank for Agriculture and Agricultural Cooperatives (BAAC) also provides loans to individual farmers and thus can be seen as a competitor.

The cooperatives could no longer operate sustainably since developments in this period weakened them. The cooperatives had less funding sources and faced increased competition due to larger competitors. They were also impacted by forced mergers which weakened them. These effects have continued to have a negatively impact on the current cooperatives.

Improvement Era (1971-Present)

In this era, cooperative development is focused on external factors such as globalization and technology advancement (Pratuckchai & Patichol, 2016). Cooperatives improve their efficiency by performing similarly to private companies, for instance, providing business services and applying management techniques. They not only provide financial services but also purchasing, marketing and food processing, as well as agricultural extension services.

Cooperative development concentrates on developing the cooperative system. The government establishes related organizations to support cooperatives. The government establishes cooperative agencies at a provincial and district level (Baumrungwong, 2001). The cooperative development fund is formed to provide funding for the cooperatives. The types of cooperatives are reduced from 22 to 8 and 6 groups in 1968 and 1973, respectively (Baumrungwong, 2001). According to the Cooperative Act B.E. 2542, cooperatives in Thailand are classified as ACs, Fisheries Cooperatives, Land-Settlement

Cooperatives, Consumer Cooperatives, Thrift and Credit Cooperatives, Service Cooperatives, and Credit Union (Cooperative League of Thailand, 2010).

The evolution of Thai cooperative is shown in Figure 2.1. As this summary has shown, Thai cooperatives have faced issues in terms of their operation model (top-down) and a lack of funding sources. This is the reason why cooperatives could not meet their members' needs. In addition, the main source of funding for cooperatives is borrowing from BAAC, while the BAAC competes with cooperatives. As a result, cooperatives cannot provide competitive credit services.

2.2.2 Current Status of Agricultural Cooperatives in Thailand

During the early stages of establishment, ACs in Thailand were multipurpose cooperatives which aimed to provide members with access to credit. After the success of the first cooperative, the Wat Chan cooperative, ACs were developed and expanded their services to facilitate members' production and marketing. The ultimate goal of ACs is to increase members' living standards (Cooperative Auditing Department, 2016a). AC objectives are as follows:

- 1) to provide loans to members at an affordable interest rate;
- 2) to promote member thrift by providing savings and deposits;
- 3) to supply the necessary farm and consumer products at reasonable prices;
- 4) to supply agricultural equipment to members at minimum cost;
- 5) to assist members in reducing production costs and increasing their yields by improving their production skills, techniques, and methods;
- 6) to help members access product markets at fair measurement and prices; and
- 7) to promote members' education through training

The structure and function of Thai ACs are explained in the following section. Thai Cooperatives are categorized using a three-tier system (see Figure 2.2): primary cooperatives at the district level, provincial federations at the provincial level, and national federations at the nation level (Thuvachote, 2007). A primary cooperative is a multipurpose cooperative formed by groups of individual members. The group of members consists of individuals living in the same village. More than five primary cooperatives are combined to form a provincial federation in order to cooperate on their targeted activities, such as food processing. The Agricultural Cooperative Federation of Thailand, as the national federation, was formed by 76 provincial agricultural cooperative federations. Moreover, there are special AC national federations, such as the Sugarcane Growers Cooperative Federation of Thailand, The Dairy Cooperative Federation of Thailand, and the Swine Raiser Cooperative Federation of Thailand, etc (Ratanamalai, 2001). The national federation provides

marketing services and input supplies to primary ACs. All ACs have to be affiliates of the CLT which promotes AC development.

In Thailand, ACs can be divided into eight types: General ACs, Para rubber producers' cooperatives, Land reform area cooperatives, Water users' cooperatives, Dairy cooperatives, Animal raiser cooperatives, BAAC customer cooperatives, and ACs in the assembly of small-scale farmers (Cooperative Auditing Department, 2015).

In terms of AC performance, the total volume of AC business has risen gradually from 85,794 million baht in 2005 to 306,672 million baht in 2013, except for 2014 (Cooperative Auditing Department, 2014). In 2014, the growth rate decreased by 4% from 2013 because of a decline in the marketing business. In terms of types of AC, the general agricultural cooperative, the rubber cooperative, and the water user cooperative had the highest numbers of ACs and account for 53.74, 18, and 12.60% of the total number of ACs, respectively (see Table 2.1). However, in terms of the number of members, the BAAC customer cooperatives and the general agricultural cooperatives had more members than other cooperatives, about 59.11 and 34.56%, respectively (see Table 2.1).

With respect to AC functions, small farmers face several constraints such as capital and land shortages, a lack of production knowledge, poor infrastructure, and unfairness in marketing. Individual farmers cannot solve these problems. Thus ACs assist them by providing five services, credit, savings and deposits, purchasing or selling agricultural supplies, marketing and food processing, as well as agricultural extension services. The ACs' services and their roles on members are explained as follows:

1) Credit Service

Lending is thought to be a necessary activity for AC members since ACs provide not only credit, in term of cash, but also agricultural material credit, for example, credit for buying seeds, fertilizers, or farm materials (Thongpukdee, 2011). The average annual interest rate for credit is between 9 to 12% (Thailand Development Research Institution, 2004).

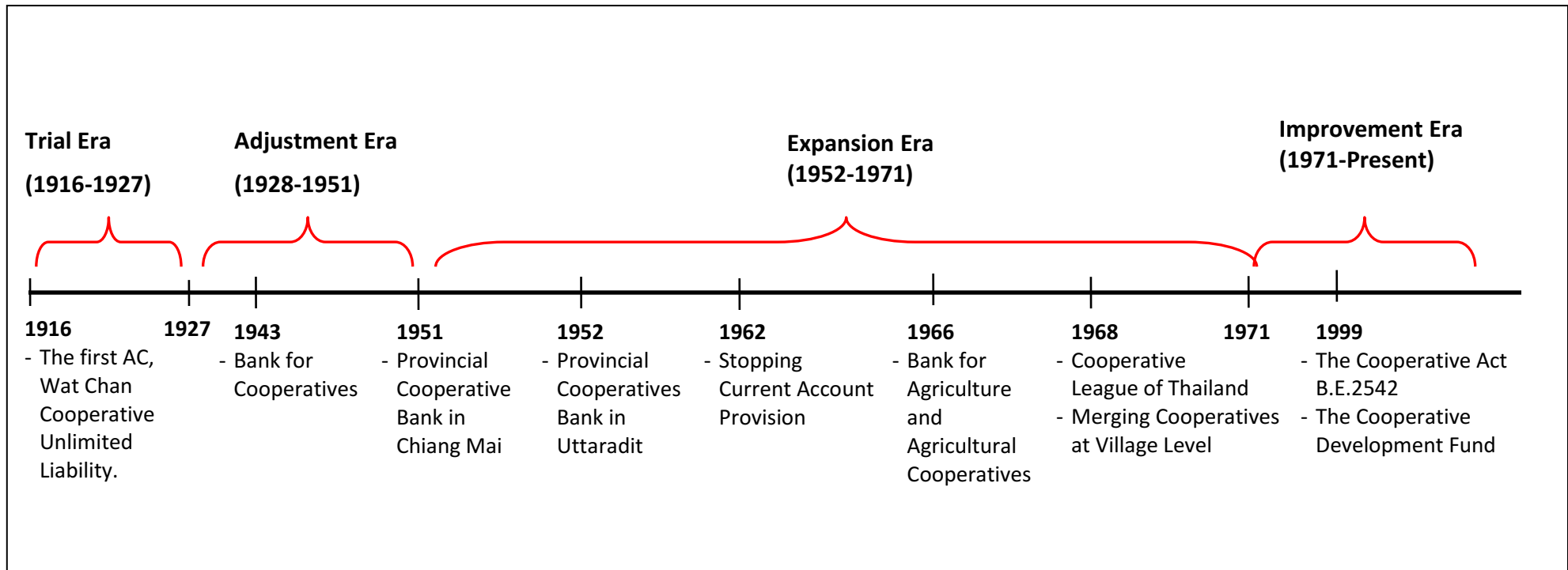


Figure 2.1 Evolution of Thai Cooperatives

Regarding cash credit, AC credit may be grouped based on duration and purpose of credit (Thuvachote, 2007). AC credit is divided into short-term, medium-term, and long-term (Thuvachote, 2007). Short-term loans are for emergency needs or farm expenditure, for purchasing fertilizers, seeds, and other farm materials (Bureau of Agricultural Economic Research, 2015). Borrowers have to repay short-term loans within two months. Medium-term loans are designed to spend on farm investment, for instance, preparing farmland and water sources. The borrowers have to pay back the money within 18 months. Finally, long-term loans are for investing in farm assets such as buying agricultural equipment, land investment, building or fixing one's house or warehouse, and debt repayment. The duration of long-term loans is five years (Thuvachote, 2007). In terms of credit purpose, credits are divided into production and consumption.

In terms of strategies to motivate members to join credit activities, ACs apply several incentives to increase members' lending. For example, when borrowing from ACs members can use assets or guarantors as collateral. ACs return benefits to borrowers in terms of patronage refunds every year based on their transactions. Moreover, ACs force members to follow rules, using customer ratings. One month after the borrowers accept AC loans, the AC officers check whether the borrowers have spent the loan for the intended purpose. ACs rank borrowers' credit levels and offer rewards such as interest rate discounts, raising a borrower's credit limits, or provide welfare services (Cooperative League of Thailand, 2018; Cooperative Promotion Department, 2017).

Recently, credit plays an important role for AC members. ACs rates of lending have risen continuously since 2005 (see Figure 2.3). ACs' lending rates have increased from 77,498.44 million baht in 2013 to 81,893.75 million baht in 2014, which is about 5.67% (Cooperative Auditing Department, 2014). About 95% of total AC loans were issued by the general agricultural cooperatives and almost 99% of loans were lent to members and the rest to other cooperatives (see Table 2.2). Approximately 55% of members' loan were short term, while 34 and 11% were medium and long term, respectively (Cooperative Auditing Department, 2015).

2) Savings and Deposit Services

Savings and deposit services are another important feature for both members and ACs. This service helps members to reduce their vulnerability and increases smooth consumption. In addition, savings and deposits are internal sources of funding for ACs. ACs provide three types of savings and deposits for members; Saving Deposit Accounts, Special Saving Deposit Accounts, and Fixed Deposit Accounts (Thuvachote, 2007).

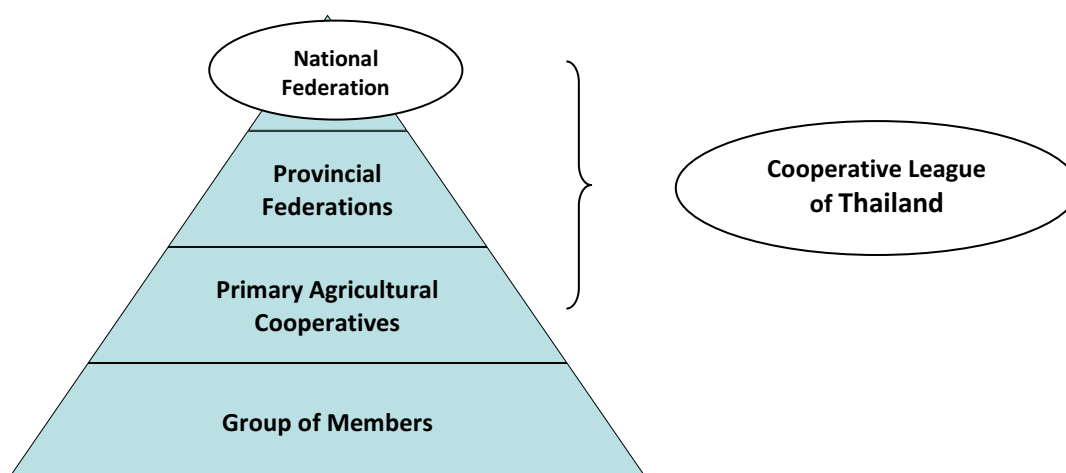


Figure 2.2 Agricultural Cooperative Structure in Thailand

Table 2.1 Number of Agricultural Cooperatives and Members, 2014 (by Type)

Type of Agricultural Cooperative	Number of ACs		Number of Members	
	Unit	Percentage	Unit	Percentage
General Agricultural Cooperatives	2,320	53.74	2,226,819	34.56
Para Rubber Producers' Cooperatives	777	18.00	126,281	1.396
Land Reform Area Cooperatives	171	3.96	77,484	1.21
Water Users' Cooperatives	544	12.60	112,967	1.75
Dairy Cooperatives	115	2.67	19,449	0.30
Animal Raiser Cooperatives	195	4.52	36,902	0.58
BAAC Customers' Cooperatives	77	1.78	3,808,412	59.11
ACs in the Assembly of Small-scale Farmer	118	2.73	34,226	0.53
Total	4,317	100.00	6,442,540	100.00

Source: Cooperative Auditing Department (2015)

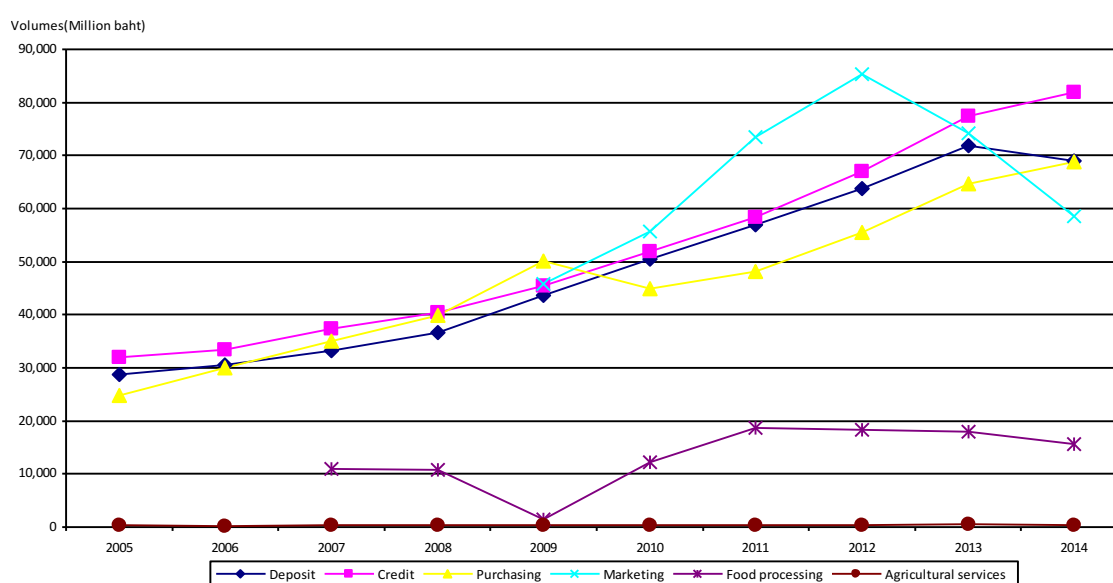


Figure 2.3 Business Volumes of Agricultural Cooperatives in Thailand (2005-2014), (By Service)

Source Cooperative Auditing Department (2014)

ACs have more focused on saving and deposit provisions. Since 2008, the volume of AC savings and deposits has continued to increase, however, the volume dropped from 71,855.54 million in 2013 to 68,970.87 million baht in 2014; equal to 4% (see Figure 2.3). Roughly 75% of the total saving volume came from members and about 7 and 18% came from other cooperatives and other sources, respectively (Cooperative Auditing Department, 2015). In terms of type of ACs, the amount of savings and deposits from general agricultural cooperatives was the highest, with about 95% of total AC savings and deposits (see Table 2.2)

3) Purchasing Services

Purchasing services provide members with access to agriculture machinery and inputs at lower prices for good quality products. ACs sell agricultural inputs and consumer goods such as farm tools, seeds, fertilizers, rice, and oil, to members. This service helps members reduce their production costs and household expenditure (Cooperative Auditing Department, 2016a).

The volume of purchasing service has gradually increased since 2005 (see Figure 2.3). In 2014, the purchasing volume was 68,796 million baht or 23.37% of the total business volume of ACs (see Table 2.2). The general agricultural cooperatives provided the greatest volume of purchasing services which was 47,734.30 million baht or 69% of the total purchasing volume. In terms of goods type, petro products and fertilizers were the highest volume with 47% and 29% in 2014, respectively (see Table 2.3).

4) Marketing Services

Marketing is an important service for assisting members in reaching markets. This service provides members with an advantage in terms of collecting and processing products. Collecting members' products for selling increases members' bargaining power. As a result, members obtain fair measurements and prices. Furthermore, members can gain more income by joining food processing services since food processing increases the value of members' products. Only a few types of ACs use marketing services such as the general agricultural cooperative, the rubber cooperative, the BAAC customers' cooperatives, and the dairy cooperatives (see Table 2.2). Similar to marketing, the food processing service is mostly offered by rubber cooperatives, dairy cooperatives, and the general agricultural cooperatives.

In terms of marketing performance, crops, rubber, raw milk, and paddy have the highest trade levels (Cooperative Auditing Department, 2015). From 2009 to 2012, the volume of marketing business gradually increased and was slightly more than the credit business (see Figure 2.3). However, the marketing volume dramatically dropped from 85,266.74 million baht in 2012 to 58,586.75 million

baht in 2014 (see Figure 2.3). The cause of declines in the marketing volume was the fall in the number of economic and energy crops, especially rubber and paddy. Decreased crop yields were due to drought and a slump in agricultural prices (Cooperative Auditing Department, 2014).

With respect to food processing volumes, since this service is only offered by a few ACs, the volume of food processing is less than the other services (see Figure 2.3). In 2014, the volume of food processing was equal to 15,700.91 million baht or 5.33% of the total AC business volumes (see Table 2.2).

5) Agricultural Extension Services

ACs encourage members to participate in agricultural extension services to solve their production problems and promote their products. ACs provide many agricultural extension services such as ploughing, land improvement, irrigation, and demonstration farms (Cooperative Auditing Department, 2016a). The volume of agricultural extension service is a small portion compared to other AC services (see Figure 2.3). In 2014, the volume was 431.88 million baht or 0.15% of ACs total business volume (see Table 2.2).

In summary, in addition to credit services, non-credit support services, particularly purchasing and marketing services are important for AC members or farmers. Purchasing products helps members to reduce their production costs and consumption expenses. Furthermore, members can attain a more competitive price by participating in AC marketing. Both services increase members' potential to compete with other traders. The general agricultural cooperatives have the greatest number of participants, which is shown by AC performance in 2014 (see Table 2.2). The business volume of the general agricultural cooperatives was the highest compared to other cooperative types.

2.2.3 Agricultural Cooperative Challenges and Innovations

Agricultural Cooperative Challenges

Thai small farmers face excess supply problem. Excess supplies lead to low prices and low bargaining power against middlemen. In addition, Thai small farmers have to compete against agribusiness enterprises under trade liberalization (Chainuvati & Athipanan, 2001). These constraints mean that small farmers have low bargaining power in terms of price and competition. Productivity, profitability, and sustainability improvement are all important for reducing poverty (Hazell, Poulton, & Wiggins, 2010; Verhofstadt & Maertens, 2014).

Table 2.2 Business Volumes of Agricultural Cooperatives in Thailand, 2014 (Type of Cooperatives)

Type of Agricultural Cooperative	Business (Million baht)						Total
	Deposits	Credit	Purchasing	Marketing	Food Processing	Agricultural Services	
General Agricultural Cooperatives	65,458.56	77,668.64	47,734.30	18,358.79	2,813.39	298.24	212,331.92
Para Rubber Producers' Cooperatives	415.51	382.30	643.58	14,609.29	7,803.43	1.23	23,855.34
Land Reform Area Cooperatives	1,045.42	1,715.97	1,071.05	3,472.15	495.15	7.44	7,807.18
Water Users' Cooperatives	561.76	1,312.48	1,096.34	887.69	0.66	79.97	3,938.90
Dairy Cooperatives	1,355.93	546.14	4,575.77	7,825.98	4,040.54	27.28	18,371.64
Animal Raiser Cooperatives	118.2	164.85	703.81	622.99	349.68	5.84	1,965.37
BAAC Customers' Cooperatives	10.18	69.21	12,955.37	12,781.54	197.99	11.07	26,025.36
ACs in the Assembly of Small-scale Farmers	5.31	34.16	16.26	28.32	0.07	0.81	84.93
Total	68,970.87	81,893.75	68,796.48	58,586.75	15,700.91	431.88	294,380.64

Source: Cooperative Auditing Department (2015)

Table 2.3 Volume of Sales of Input and Machinery by Agricultural Cooperatives in Thailand, 2013-2014

Products	Unit: million baht		
	2013	2014	Growth (%)
Fertilizer	17,652.10	18,737.40	6.15
Machinery	1,231.67	915.64	-25.66
Animal Feed	4,800.19	4,773.02	-0.57
Rice	1,251.58	1,475.91	17.92
Seed	1,879.52	2,503.12	33.18
Insecticides/Pesticides	558.51	670.61	20.07
Petrol	29,138.04	30,331.22	4.09
Consumption Goods	819.48	1,091.42	33.18
Other	3,900.65	4,154.14	6.50
Total	61,231.74	64,652.48	5.59

Source: Cooperative Auditing Department (2014)

Most Thai ACs in Thailand are established to solve excess supply problems and increase farmers' access to markets. Small farmers assume greater bargaining power when they are members of ACs. They can coordinate with agriculture enterprises in the supply chains; this reduces transaction costs and improves their bargaining power (Reardon, Barrett, Berdegue, & Swinnen, 2009; World Bank, 2007). Furthermore, AC members who are trained in new techniques and forms of knowledge can improve their productivity. The improved productivity increases members' well-being.

However, ACs confront several challenges in an open market economy, including increasing diversification of members, and changes in consumer preferences (Lee, 2006; Thuvachote, 2007). Open market economies mean that ACs must compete with private traders who have modern technological innovation, large-scale marketing schemes, and more resources. Moreover, the changes in international agricultural trade regimes make small farmers face even higher levels of competition. Second, ACs meet members' different needs. Members need different services but ACs have limited resources. ACs have to operate efficiently to respond to their members' needs. Furthermore, members want to sell their products as soon as possible and obtain better returns. Lastly, ACs have to deliver products that match consumer preferences. Recently, consumers have become more aware and concerned about the quality of products, particularly in terms of the use of chemicals, and want to buy quality goods at reasonable prices.

On account of these challenges, there are only a few successful ACs in Thailand. These include the KAC, the PFC, the GNC, and the Tha-Yang Cooperative Ltd. (Tanrattanaphong, 2015). The KAC, which is a group of fruit farmers in the Chanthaburi province, has used purchasing and marketing services as the main tools to solve excess fruit supply (Tanrattanaphong, 2015). As a result, the KAC's revenue was equal to \$6.18 million in 2014 with a net profit of \$94,000. Approximately 98% of the total business volume was accounted for through purchasing and marketing services. In terms of members' benefit, members were able to sell two thousand tons of mangosteens through the KAC in 2014. Moreover, KAC members receive a dividend of 4.5 % per year.

The PFC have succeeded in strengthening business networks and providing high member returns (Tanrattanaphong, 2015). Members confronted with excess supply and low price offered by middleman. PFC also solved excess supply and low price problems by applying marketing services. The PFC collects members' products and sells them directly to consumers. This strategy reduces the role of middlemen and enables members to gain a stable price. The PFC's business volume is approximately \$3 million dollars per year and about 1.2 thousand tons of members' products are sold annually. As a result of new techniques and production supported by the PFC, members have been able to increase their production from 4,000 to 30,000 kilograms per year. The GNC has succeeded in developing fair markets for organic farm products (Tanrattanaphong, 2015). The GNC

was established to help small farmers access markets and achieve a higher price. In 2014, the GNC had a business volume of about \$2.5 million and they pay a dividend of 10% per year to members.

In terms of social benefits, the impact on members is not clear. Not many ACs provide members with social welfare benefits. Some, like the KAC, have established a welfare fund to support farmers in the case of disaster, to provide new techniques and knowledge, and to encourage young people to work in agriculture.

However, most Thai ACs do not work efficiently enough to promote rural households' welfare (Baumrungwong, 2001; Center for Social Innovation and Participation, 2012; Patrawart, Trikethsamphan, Lekudornkorn, Sangpheth, & Ausakulwattana, 2001). They are confronted by low levels of member participation, which is a major problem. Without member cooperation, ACs cannot develop the members' products to meet market needs and marketing service are not effective. The reason why most of Thai ACs have low member participation is that their services do not meet members' needs. ACs rely on government support, thus their policies and programs are top-down policies designed by the government. A few ACs have succeeded in their business and assisting their members because they have implemented strategies which satisfy members' need.

Agricultural Cooperative Innovations

Under high levels of market competitiveness, ACs have to create new innovations or strategies to ensure business sustainability. New strategies not only contribute to ACs' performance but also assist their members in gaining market competitiveness. AC performance directly affects members' benefits (Tanrattanaphong, 2015). Successful ACs provide high quality services to assist members in terms of cost saving, improved production process, and access to fair markets prices. Therefore, successful ACs can bring about greater member benefits. New innovations or strategies are discussed briefly below:

1) Collaboration with Private Companies

Business partnerships are very important for ACs, because they enable them to develop their products and provide access to market. ACs should be supported by private companies which have expertise in marketing and research and development (Tanrattanaphong, 2015). ACs gain some advantages from companies, such as market enhancement and product development. ACs can increase market shares by selling products via different market channels provided by private companies. For instance, the KAC enhances the market for quality fruits by selling products to big supermarkets, both domestic and abroad. Thus KAC members need export knowledge (regulations and criteria for exporting fruit). This knowledge is provided by private companies. In addition, ACs can enhance market shares by selling their products under the trademark of private companies. An

example of successful partnership strategy is cooperation among 12 ACs in the Northeast of Thailand with Amway Corporation (Thuvachote, 2007). They produce rice under the brand “Amway Hom Mali Rice” for the premium market. Since Amway is a big and famous direct-sale company and consumers believe in the product quality, selling rice through the Amway trademark increases AC members’ sales and the price they get for their rice.

Another benefit from collaborating with private companies is product development. The PFC and the freezer-storage company have worked together to develop a long life technology; vacuum packed fish. Due to this innovation, the FPC can now export their products to international markets.

2) High-quality Products

Product quality is necessary to obtain high prices and build one’s market share. Several ACs are successful because they improve their product quality. Successful Thai ACs provide knowledge and new techniques which improve production processes. The most successful AC in this area is the Tha-yang Agricultural Cooperative Ltd (Thuvachote, 2007). Tha-Yang encourages its members to produce high quality bananas. The AC collects members’ produce and sells them to various markets. Due to high quality of organic banana, the AC can export the bananas to Japan where they gain a higher price (Thayang Agricultural Co-operative Ltd., 2016). Many ACs, such as the Ban-lat Agricultural Cooperative Ltd. and the Thung-Ka-Wat Farmers’ Group have applied Tha-Yang Agricultural cooperative’s concept to improve and sell members’ bananas to overseas destinations. KAC and PFC have also applied quality improvement strategies (Tanrattanaphong, 2015). The KAC focuses on high quality fruits in order to resolve the excess supply of fruit and obtain higher prices. The KAC encourages members to improve fruit quality by providing new technologies and quality inputs. Similarly, improving product quality is an important strategy for the PFC. The PFC procures fingerlings for members in order to obtain high quality of Nile tilapia from PFC members. Due to the high quality of Nile tilapia, PFC members have greater bargaining power which enables them to sell their produce at a higher price.

3) Electronic Commerce (E-commerce)

E-commerce is a new market channel for current commerce. The Cooperative Promotion Department (CPD) has encouraged Thai ACs to establish websites to sell their products. E-commerce helps ACs to reduce the role of middlemen, since it connects producers to consumers. However, this strategy has had limited success, as designing and operating websites need staff who specialize in information technology (Thuvachote, 2007).

4) Cooperative Women's Group (CWG)

The aim of the Cooperative Women's Group is to promote income, health care, and moral activities for households. The CWG plays an important role in non-farm activities and generates more income for households (Thuvachote, 2007). At present, there are approximately 1,300 CWG groups throughout Thailand. The CWG of ACs generates household income by producing processed food and handicraft products. For example, the Panmai cooperative, which is a group of poor women in the northeast of Thailand, produces silk textiles (Counting flowers, 2016). The Panmai cooperative trains members to weave fabric and provides them with micro-credit. Members' of Panmai improve their household income through selling weaved textiles. Increased income improves the lives on their families.

5) Cooperative Company

The cooperative company concept is applied in order to support the stability and cost effectiveness for AC businesses. The cooperative company is a conglomeration of ACs which work together. The cooperative company belongs to, and is controlled by, ACs. For example, the Thai Agri-Business Co., Ltd (TABCO) was established by 74 ACs to provide purchasing and marketing services for members (Thuvachote, 2007). TABCO buys and distributes materials and farm equipment production. Furthermore, TABCO collects and delivers members' farm products to various markets. The cooperative company helps ACs increase their bargaining power and obtain fairer prices.

6) Associate Members or Open Membership

An associate member is another strategy ACs apply in order to expand their businesses. ACs allow people who are not farmers but who live in the village to be members. The associate members cannot vote in AC business management, however, they can participate in AC services, which differ from one AC to another AC. For instance, the Ban Lat Agricultural Cooperative, Ltd. have admitted 4,000 associated members (Thuvachote, 2007). They cannot access credit and marketing services, but they are eligible to join saving, purchasing, and agricultural extension services. The inclusion of associate members increases ACs' capital and business scale.

7) Value-Addition

A value-added operation refers to the process of adding value to raw farm products; this occurs through processing and marketing services, such as grading and packaging (Prakash, 2000). Value-addition helps ACs gaining competitive advantages since it distinguishes AC products from those of competitors. In Thailand, the Kaset-Visai Agricultural Cooperative Ltd, in Roi-Ed province and the Tap-Pratan farmers' Group in Ang-Thong province have been successful in adding value to members'

products (Thuvachote, 2007). The Kaset-Visai Agricultural Cooperative created its own brand for Hom-Mali rice. The Kaset Visai district is one of the most important areas for jasmine rice production in Thailand. Therefore, the trademark, Kaset-Visai Hom-mali, makes consumers believe in the rice quality of the Kaset-Visai Agricultural Cooperative Ltd. The Tap-Pratan farmers' Group added value to their rice by changing plain rice to herb-coated rice, to respond high demand. Rice from the Tap-Pratan Farmers' Group is different from other rice since it is organic rice.

8) Marketing Services

AC marketing services enable members to access various markets. For example, the GNC has been successful AC in solving members' access to different markets. The GNC has succeeded in distributing a variety of organic farm products from small farmers to domestic and overseas markets, such as rice, coconut milk, herbal teas, and soybeans (Tanrattanaphong, 2015). The GNC is a distribution centre which collects farm products from members, provides a logistic system, and distributes members' products to suitable channels. The GNC logistic system is an important service as it assists members to access domestic and overseas markets, which would not be possible individually. The Maechan Cooperative has helped to decrease the reliance on middlemen, increasing members' accessibility to different markets, and has ultimately resulted in them receiving higher prices. The Maechan cooperative has succeeded in inducing members to sell their products through ACs, because the cooperative has the market power to negotiate and obtain higher prices for members (Autta, 2014).

9) Member Participation

Member participation is a crucial factor in product improvement. Members should participate in ACs to learn about new production techniques, which leads to product improvements. Abate, Francesconi, and Getnet (2014) find that in Ethiopia AC participants' productivity is greater than non-participants. Improvements are the result of using production technologies and support services provided by ACs, such as training and extension services. Moreover, the ACs' performance depends on the business volume traded by members. The higher the level of members' participation, the more successful the ACs are. For example, KAC's revenue grew from \$1.55 million in 2010 to \$6.18 million in 2014, which is approximately 75%. KAC's growth was a direct result of member participation in purchasing and marketing services, which equals 98% of KAC's business (Tanrattanaphong, 2015).

10) Value Network

Value network development is a recent innovation implemented by Thai ACs to increase their market competition. ACs attempt to develop networks between themselves (a horizontal network) and other related stakeholders in the supply chain (a vertical network), to deliver farm products to consumers (Patrawart & Sriurai, 2010). The horizontal network enables AC members to access their services easily and encourages ACs to share their resources leading to reduction in an operation cost and improvement in AC efficiency (Intawang & Wingwon, 2014). The network efficiency is determined by information, inventory, transportation, and facility management among ACs (Ritthaisong, Akasart, Apisitpinyo, Tungprasert, & Jumpasri, 2018). The vertical network is working together with other AC members, government officers, and enterprises to improve their supply chain, from upstream to downstream enterprises, emphasising fairness and sustainability (Academic Cooperative Institute, 2015). The network helps AC members solve their problems (such as an excess of supply and the low price of farm products) and extend their market to include both domestic and international markets.

At present, there are six successful networks; The Fruit Value Network, The Thai Co-operative Jasmine Rice Value Network, The Rubber Value Network, The Coffee Value Network, The Cassava Value Network, and The Moral Rice Value Network (Academic Co-operative Institute, 2015). ACs in the value network work closely together in order to develop, extend, and improve their networks. For instance, the Fruit Value Network is organized by ACs whose members produce high-quality fruits. The network supports ACs to find markets by making contract with buyers, such as wholesalers and supermarkets. Another interesting network is the Thai Co-operative Jasmine Rice Value Network which consists of 16 ACs in five provinces, Roi-Et, Surin, Buriram, Mahasarakham, and Nakhonratchasima. The Thai Co-operative Jasmine Rice Value Network coordinates with ACs and rice retailers to develop marketing channel for small farmers. The network links rice producers in the supply chain and helps members manage their trade. Members of the rice value network sell rice using the network's trademark, Kerdboon. Finally, the Rubber Value Network in Trang province has established production and marketing activities for rubber producers. The rubber network has created business partnerships with rubber exporters, Thanumtip farmer group, and a company in Malaysia, the Euroma rubber industry. The Thanumtip farmer group and Euroma rubber industry help the rubber network access the rubber market in Malaysia. Furthermore, they help the rubber network to improve members' rubber production and develop the rubber network in order to link the network with rubber ACs in China.

Among all of the strategy identified above, the level of member participation is the dominant factor in AC success. As Prakash (2000) find that members influence the success of Japanese agricultural cooperatives (JAs). In 1995, JAs faced low member participation about 3,642 members per AC, since

the JAs did not provide services that could help members to compete in the market (Prakash, 2000). Due to low member participation, the non-performing JAs had to cease operations. The number of Japanese ACs decreased from 12,000 ACs in 1960 to 1,500 ACs in 1999.

Prakash (2000) find that members will only join in with business and organizational affairs if ACs can response their needs. Members or farmers expect that they can sell their products by obtaining timely and sufficient return. Two important innovations that lead to higher returns are value-added and marketing. Farmers' expectations around marketing services include the provision of post-harvest services, warehousing, grading, packaging, shipment, and market information.

Besides marketing services, farmers need credit, purchasing or supplies, and extension services (Prakash, 2000). Farmers need easy access to credit. Credit for farmers includes credit for the purchase of seeds, field maintenance, and investment such as tube wells, and farm cattle. In addition, farmers need ACs to supply farm technology and farm inputs such as fertilizers, farm chemicals, farm machines and implements. With respect to extension services, farmers need assistance and advice on technical production, as well as infrastructure development.

2.3 Role of Agricultural Cooperatives in Thai Rural Economy

ACs play an important role in Thai rural households. ACs provide a wide range of support services, from production to delivery to customers. Generally, ACs engage in five services; credit, savings, purchasing, marketing and food processing, as well as agriculture extension services. AC services can be grouped in credit and non-credit support services. Using credit services, members are able to access finance. Non-credit support services enhance members' access to input and output markets. The next section explains the roles of ACs in Thai rural financial and agricultural markets.

2.3.1 Role of Agricultural Cooperatives in Rural Financial Markets in Thailand

In the early period, the Thai rural finance market was monopolized by informal lenders such as individual moneylenders, relatives, and shop owners selling goods with instalment plans (Siamwalla et al., 1990). The government wanted to expand credit options for rural households, with low interest rates to rural households in order to reduce their dependence on informal credit. In 1916, formal loans were provided to rural households via credit cooperatives (Siamwalla et al., 1990). However, cooperatives faced high default rates. To remedy this problem, the government established the BAAC in 1966, a specialized financial institution which provided direct credit to farm households. In 1975, to increase rural households' access to credit, the Bank of Thailand asked commercial banks to lend to farm households. At present, rural credit is served by formal, semi-formal, and informal financial institutions. Formal financial institution consists of commercial banks and the BAAC. Semi-formal institution includes the ACs, Village Fund, and the Production Credit

Group (PCG). Key players in the informal group are neighbours, relatives, moneylenders, store owners, input suppliers, landlords, and output purchasers (Townsend, Killian, & Killian, 2016).

In 2013, household credit use in urban and rural areas decreased from 41.53% in 2010 to 39.50% in 2013 (Bank of Thailand, 2013). Similarly, Townsend (2016) found that rural households' borrowing decreased from 78% in 2008 to 66% in 2014. The reason for this is too high interest rates and fees. Moreover, the loan conditions were complicated and the credit limit was insufficient (Bank of Thailand, 2013).

Regarding sources of credit, rural households' dependence on loans provided by informal lenders decreased from 7.28% in 2008 to 2.18% in 2014 (see Table 2.4). Main credit providers for rural households are the Village Fund, BAAC, and ACs, with 53.78, 25.16, and 5.43% of total rural households' credit in 2014, respectively.

Agricultural credit is necessary for rural households since a major portion of rural population works in the agricultural sector. They are small-scale farmers who lack funds needed for production investment (Limsombunchai, 2006). Table 2.5 shows that households' outstanding debt in the agricultural sector increased from 204,117.40 million baht in 1999 to 453,339.94 million baht in 2012, or by around 55%. Moreover, 30% of agricultural households have more debt than income (Chatarat, Attavanich, & Sangimnet, 2018). In 2017, the average debt of farm households was 1.3 times as much as their income and debt per capita was 74,141.60 baht. In terms of the number of indebted households, in 2013 the percentage of farm households with debt was equal to 53.11% of total households in the agriculture sector (see Figure 2.4). Figure 2.4 shows that most of the indebted households (2,681,505 households or 85% of the total indebted households) borrowed money to invest in agricultural production.

BAAC is the main credit providers for farm households. In 2013, almost 53% of total farm households were indebted to BAAC (see Table 2.6). The second and third highest providers were the Village Fund and Cooperatives with around 33 and 10% of total farm households, respectively. ACs are not the main credit providers since they do not have enough funds to meet the high credit demands and therefore cannot compete with BAAC. In 2013, about 8.26% of total Thai households were able to access loans provided by semi-formal financial institutions (Bank of Thailand, 2013).

Although ACs are not the major credit providers in Thailand, they still play a significant role in assisting low-income people. Table 2.6 shows that most AC members (97,289 members) borrow between 10,000 baht to 50,000 baht, while most households borrowing from BAAC, borrow in the range of 20,000 baht to 500,000 baht. This data implies that BAAC borrowers are wealthier than AC members, since the wealthier households are able to borrow greater amounts. This is supported by

Poapongsakorn et al.'s (2015) findings. They find that non-poor farm households borrow twice as much as low-income households.

Table 2.7 shows that AC credit performance has increased since 2005. Approved loans increased by approximately 61% from 2005 to 2014. 99% of total AC loans were individual loans (see Table 2.7). In 2014, about 54% of the total loans or 44,242 million bahts were short-term loans which were used for emergency needs and production expenses. About 33% of AC total loans or 27,362.17 million were medium-term loans for production expenses during the crop season.

Table 2.4 Percentage of Rural Household Borrowing, 2008 and 2014 (Type of Credit Provider)

Credit Providers	2008	2014
Formal Financial Institutions	23.67	25.95
BAAC	22.91	25.16
Commercial Bank	0.58	0.79
Others such as Rice Bank	0.18	-
Semi-formal Financial Institutions	54.51	61.63
Agricultural Cooperatives	5.58	5.43
Village Fund	43.23	53.78
PCG	5.70	2.42
Informal Financial Institutions	7.28	2.18
Neighbours	0.73	0.04
Relatives	2.35	0.63
Money Lender	2.01	0.67
Store Owner	1.37	0.54
Input Suppliers	0.07	0.17
Landlords	0.03	-
Output Purchasers	0.09	0.13
Others	14.52	10.24

Source: Townsend et al. (2016)²

Table 2.5 Outstanding Debt of Farm Households in Thailand (1999-2012)

Year	Farm Households' Debt (Million Baht)	Percentage Change
1999	204,117.40	-
2002	245,563.14	20.30
2007	393,839.96	60.38
2009	319,093.99	-18.98
2011	351,135.64	10.04
2012	453,339.94	29.11

Source: Office of Agricultural Economics (2014)

² Townsend Thai Project Households Annual Resurvey collected data from 6 provinces, Chachoengsao, Lopburi, Buriram, Sisaket, Satun, and Phrae.

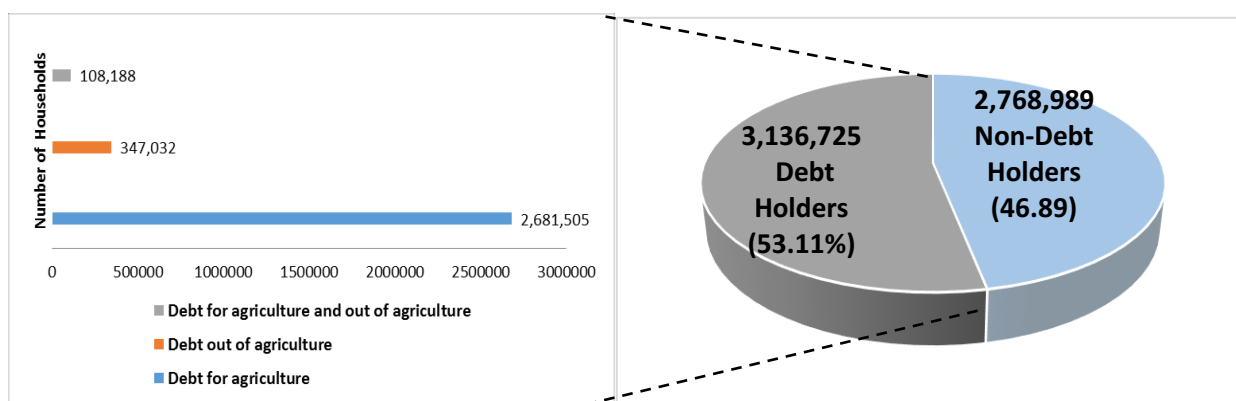


Figure 2.4 Numbers of Indebted Farm Households in Thailand, by purpose (2013)

Source: National Statistical Office (2013)

2.3.2 Role of Agricultural Cooperatives in the Thai Agricultural Market

AC marketing services are believed to assist farmers in reducing transaction costs and increasing their bargaining power in the market. However, farmers do not always trade through ACs because they often lack efficient management and infrastructure, which links them to the different markets (Kainara, 2015). The share of agricultural products traded through the AC channel to total domestic agricultural products is less than 20%.

AC marketing has positively contributed to the national agricultural market. The AC marketing transaction ratio for domestic agricultural products had been ranked from 9 to 19% over the last 10 years (2005-2014) (see Table 2.8). The ratio of AC marketing volume to domestic agricultural products has fluctuated. The ratio gradually increased from approximately 10% in 2009 to 19% in 2012. The ratio rose due to a growth in farm products traded via ACs. It peaked at 125.79 billion baht in 2012 (see Table 2.8). After 2012, the AC marketing volume decreased to 89.40 billion baht in 2014. As a result, the ratio of agriculture products traded via ACs to domestic agricultural products fell to 13.43% in 2014. The ratio decreased because of declines in para-rubber and paddy sales via ACs.

Table 2.6 Number of Debt-Holding Households in the Agricultural Sector in Thailand (Source of Loan, 2013)

Source of Loan	Amount of Debt (Baht)									Total
	Under 2,001	2,001-5,000	5,001-10,000	10,001-20,000	20,001-50,000	50,001-100,000	100,001-500,000	500,001-1,000,000	Over 1,000,000	
BAAC	4,710	15,574	41,021	108,415	457,815	406,942	503,401	35,660	8,582	1,582,120
Other Banks	408	1,015	2,686	5,534	13,160	10,136	14,400	3,729	2,916	53,984
Cooperatives/Farmer's Group	2,019	7,401	15,557	34,459	97,289	71,248	57,374	3,669	1,226	290,242
Village Fund	10,793	25,438	135,024	390,443	349,488	62,835	8,621	518	151	983,311
Other Government Agencies	699	4,086	4,070	2,706	2,546	1,366	1,612	928	930	18,943
Middleman	254	946	1,264	2,142	4,223	2,556	2,772	564	196	14,917
Money Lender	363	1,002	2,134	3,949	7,568	4,816	4,259	626	199	24,916
Relative/Neighbour/Others	1,049	2,762	5,433	7,321	12,614	6,918	5,577	571	188	42,433

Source: National Statistical Office (2013)

Table 2.7 Credit Outstanding Provided by Agricultural Cooperatives (2005-2014) (Credit Type)

Year	Credit for Members					Credit for other ACs	Percentage	Total
	Short-term	Medium-Term	Long-term	Total	Percentage			
2005	18,895.35	11,857.25	1,066.41	31,819.01	99.35	207.94	0.65	32,026.95
2006	19,526.65	12,800.83	932.15	33,259.63	99.51	163.49	0.49	33,423.12
2007	22,170.24	13,497.99	1,432.16	37,100.39	99.43	212.27	0.57	37,312.66
2008	24,113.51	14,471.43	1,568.36	40,153.30	99.46	216.66	0.54	40,369.96
2009	27,817.29	15,571.94	1,819.78	45,209.01	99.65	157.92	0.35	45,366.93
2010	31,250.15	17,741.63	2,486.87	51,478.65	99.33	347.76	0.67	51,826.41
2011	34,179.79	19,822.86	3,561.97	57,564.62	98.46	902.58	1.54	58,467.20
2012	38,316.93	22,410.96	5,537.05	66,264.94	98.90	738.78	1.10	67,003.72
2013	40,657.45	25,529.40	10,521.22	76,708.07	98.98	790.37	1.02	77,498.44
2014	44,248.62	27,362.17	9,132.54	80,743.33	98.60	1,150.42	1.40	81,893.75

Source: Cooperative Auditing Department (2014)

The volume of AC marketing is dominated by three products; para-rubber, raw milk, and paddy. In 2014, the portion of para-rubber, raw milk, and paddy traded through ACs were about 54, 21, and 9% of the total volume of AC marketing, respectively (see Table 2.9). The decrease in marketing volume of ACs was due to the dramatic decrease in paddy and para-rubber output. The paddy volume dropped from 17,279.20 million baht in 2010 to 5,287.54 million baht in 2014, equivalent to an approximate 69% fall. The decreased paddy volume occurred due to the reduction in rice planting and the lack of a government subsidy from the government (Bank of Thailand, 2015). Para-rubber volumes traded via ACs reduced from 55,943.38 million baht in 2012 to 31,741.37 million baht in 2014 (about 43%). The quantity of para-rubber products increased by 1%, however, the price of para-rubber declined by 25% compared to the 2013 price (Bank of Thailand, 2015). As a result, the volume of para-rubber decreased.

Table 2.8 Share of Cooperative Marketed Agricultural Products to Domestic Agricultural Product Values in Thailand, 2005-2014

Unit: Billions of Baht			
Year	Volume of AC Marketing and Processing Businesses (1)	Domestic Agricultural Product (2)	Ratio of (1) to (2) in Percentage
2009	59.45	603.7	9.85
2010	76.37	600.9	12.71
2011	108.95	638.7	17.56
2012	125.79	656.0	19.18
2013	110.97	661.3	16.78
2014	89.40	665.8	13.43

Source: Cooperative Auditing Department (2016b) and Bank of Thailand (2016)

Table 2.9 Volume of Agricultural Products Traded through Agricultural Cooperatives in Thailand, 2007-2014

Unit: Million Baht						
Year	Paddy	Para-rubber	Other Crops	Raw Milk	Animal	Total
2007	6,802.93	18,324.63	4,002.06	4,946.37	490.85	34,566.84
2008	7,359.42	22,423.43	7,344.77	6,757.55	801.54	44,656.71
2009	13,814.21	19,948.03	5,673.37	7,730.04	500.48	47,666.13
2010	17,279.20	22,389.80	6,547.72	8,549.73	634.09	55,400.54
2011	11,615.66	50,634.35	9,300.32	8,089.64	390.10	80,030.07
2012	11,151.44	55,943.38	12,523.49	8,549.73	390.10	88,558.14
2013	7,085.07	45,711.35	12,220.88	8,746.60	386.91	74,150.81
2014	5,287.54	31,741.37	12,344.07	8,825.59	366.16	58,586.75

Source: Cooperative Auditing Department (2014)

2.4 Role of Agricultural Cooperatives in Poverty Reduction

To alleviate Thai rural households' poverty, ACs should have a good understanding of how credit and non-credit support services can improve rural households' economic and social welfare such as income, consumption, and human capital development. In order to understand how ACs help rural households in combating poverty, this section reviews the role of ACs in assisting households to alleviate poverty in general and more specifically in Thailand.

2.4.1 Role of Agricultural Cooperatives in Poverty Reduction

As ACs provide microfinance services like any other MFIs. Besides credit and savings, ACs also provide non-credit support programs. For example, supply cooperatives provide agricultural extension services, agricultural inputs in order to assist and improve members' production. Marketing cooperatives provide collection, packing, and distribution for members' products. AC services usage enhances capital accessibility, improves productivity, and employment opportunities for members. These contributions lead to increased income and member wellbeing.

ACs provide members with access to capital, especially credit and human capitals. This finding has been confirmed by several global studies (Chagwiza, Muradian, & Ruben, 2016; Tamirat, 2015; Wanyama, Develtere, & Pollet, 2008). A lack of capital access is a cause of household poverty, in general (World Bank, 2000). Capital is utilized in economic activities to generate income and improve household levels of wellbeing. These ultimately lead to poverty reduction (Tamirat, 2015).

ACs enable members to access credit. Credit access indirectly influences household productivity and income through production investment and human capital (Awotide, Abdoulaye, Alene, & Manyong, 2015; Kannan, 2011; Tamirat, 2015). Awotide et al. (2015) study the relationship between agricultural credit and crop production in Nigeria. They find that Nigeria rural households who take credit have higher capacity in cassava production than those who do not. The reason is farmers may spend credit on production technology improvements and farm investment such as technology use and purchasing fertilizers and inputs.

ACs also help to improve members' productivity. AC agricultural extension services directly improve members' production capacities, leading to an increase in revenue. Agricultural extension services include training, infrastructure and technology provisions, and land maintenance. The Food and Agriculture Organization of the United Nation (2012b) find that farmers who join Kenya, Uganda, and the United Republic of Tanzania ACs, learn new skills and techniques via group participation. As a result, the average agricultural income of the three countries increases by 61%. Agricultural productivity in Kenya increases by around 80%. Increased productivity is a potential means to alleviate rural households' poverty (Somavia, 2003). Besides, poor people can take advantage of their

increased income by further extending income-generating businesses. For instance, farmers in the Democratic Republic of the Congo improve their cassava production by participating in the Purchase for Progress (P4P) cooperative. In 2009, farmers were able to plant and harvest more cassava, increasing from 0.2 hectares to 1.3 hectares and received USD 220. The farmers also invested in other economic activities financed by increased income and established small shops. Finally, the farmers earned profits equal to USD 1260 (Food and Agriculture Organization of the United Nations, 2012b). The P4P program focuses on developing farm skills and market access. The impact of the program not only exists in agricultural production but the participants can also apply knowledge and skills to invest further in economic activities. Skill development is central to self-sufficiency.

Employment creation is related to access to credit. Credit offers members a chance to invest more in productive assets and perform economic activities. The expansion of production creates more jobs for members and non-members. Entrepreneurs financed by AC credit can start or extend their agriculture businesses, which then means that they need to hire more workers. There were 924,000 Kenya farmers and 900,000 people in Ethiopia who could continue their farm enterprises due to receiving income via ACs (Wanyama et al., 2008). Moreover, cooperatives are important organizations because they generate a lot more jobs. Global cooperatives created 100 million new positions (Chavez Hertig, 2008). Dairy cooperatives in India have created approximately 13 million jobs in the agricultural sector. France and Italy cooperatives have generated more than a million positions and cooperatives in Wisconsin, the US created 71% of total employment (Chavez Hertig, 2008).

2.4.2 Role of Agricultural Cooperatives in Poverty Reduction for Thai Rural Households

More than 85% of the poor in Thailand live in rural areas (Lewis et al., 2013) and they are small and medium sized farmers (Thuvachote, 2011). They have restricted access to financial and product markets. ACs are one of the main sources of credit for Thai farmers since they provide many types of loans without credit limits that meet borrowers' needs. Thai ACs aim to support their members in terms of agricultural operation, in terms of production development, marketing, and improve their well-being (Registrar and Law Office, 2016). In order to link production activities and distribution, ACs have developed non-credit support services to promote efficient credit use. Integrated services are more effective rather than credit alone in improving income and well-being. Non-credit support services create productivity development and opportunities to access markets. Agricultural extension services encourage members to improve their skills and production. These lead to improved farm yields. Purchasing and marketing services enable members to obtain fair prices due to AC bargaining power, eventually improving their income (Preedasak & NaRanong, 2001).

Thai ACs provide member benefits in the same way that other ACs worldwide do, such as improving access to capital, income, employment, productivity and social development. As discussed previously, ACs improve members' human and physical capital. Farmers' and their families' human capital will improve if credit is invested in education, training, and healthcare services. Moreover, the supply chain connection built up by ACs increases members' market accessibility. AC members can reduce transaction costs and buy input products and agriculture outputs at reasonable prices (Chagwiza et al., 2016). For example, the Phak Hai Agricultural Cooperative has connected with other stakeholders in the supply chain link to enhance AC competitiveness (Ratanamaneichat, Rakkarn, Suwandee, & Nakrungrueng, 2016). The Phak Hai AC works together with local investors and seed suppliers to develop the flooding endurance rice seeds and build a rice mill to control rice quality. Moreover, the Phak Hai cooperates with other rice ACs to create their own rice brand and extend their markets by setting up a farmer local market and creating a mobile shop such as e-commerce marketing channel. As a result, the members of Phak Hai AC increase over 25%. The AC's income of rice sales increases four times and members earn double income.

Thai ACs generate income for members through several methods. Firstly, the members receive patronage refunds and dividends (Thuvachote, 2011). In 2004, Thai ACs distributed 54.1% of their annual net profits to their members, 44.6% for dividends and 9.5% for patronage refunds (Artharee, 2007, as cited in Thuvachote, 2011). In addition, via purchasing and marketing businesses, ACs are able to increase income margins for members since ACs can negotiate better prices and provide fair weights and quality for members' products (Calkins & Ngo, 2010; Wanyama et al., 2008). In Thailand, the Thaworn Pattana Karasin Agricultural Cooperative is a successful AC that sells members' farm products. The members received an annual income of 37,879 baht, which is higher than 30,785 baht earned by non-members (Juraporn, 2004, as cited in Thuvachote, 2011). Lastly, the food processing businesses help members to create value added products. For example, the Tha-Yang cooperative which has successfully exported nonchemical bananas to Japan, increased the margin price by 6% and earned more than 30,000 baht per year for each household in 2006 (Thuvachote, 2011).

Thai ACs create employment opportunities in three ways (Wanyama et al., 2008). First, ACs hire workers to work in AC businesses. ACs create both temporary and permanent jobs through working in the organization and supporting businesses such as purchasing, marketing, and processing activities. Thuvachote (2011) reports that Thai ACs provide 7,000 jobs every year. ACs employ around 55,000 seasonal labourers for marketing and processing businesses. Secondly, the ACs increase self-employment for members. The increase in self-employment is the result of obtaining more credit. Credit offers members a chance to invest more in productive assets and economic activities. Increased production creates more jobs. In 2009, Thai ACs generated more than 6 million self-employed persons and 234,593 employments in the agriculture activities (Thuvachote, 2011). Lastly,

non-members are employed through spillover effects. Access to more credit provides jobs, not only for members but non-members as well. Companies which work with ACs hire staffs for their business operations. For example, in Thailand, the packaging company, which produces containers for dairy cooperatives' products, hires non-members as employees (Thuvachote, 2011)

ACs also increase well-being. For instance, training programs are offered to improve members' capability to generate more income. Some ACs provide welfare expenses, such as medical, educational, and funeral expenditures for members through social funds (Thuvachote, 2011). In 2005, 98.65% and 59.06% of total Thai ACs spent their net profits on member and non-member training and education, respectively (Apichai, 2007, as cited in Thuvachote, 2011).

2.5 Chapter Summary

Cooperatives are voluntary organizations owned and controlled by their users to serve their members' needs. Thai ACs are multipurpose cooperatives which provide members with access to credit, markets, and agricultural extension services. Thai ACs provide member benefits in the same way that other ACs worldwide do. ACs improve members' human and physical capital. Farmers' and their families' human capital will improve if credit is invested in education, training, and healthcare services. Moreover, the supply chain connection built up by ACs increases members' market accessibility. AC members can reduce transaction costs, buy input products, and sell agriculture outputs at reasonable prices. ACs are able to increase income margins for members since ACs can negotiate better prices and provide fair weights and quality for members' products. Moreover, Thai ACs create employment opportunity and provide a social fund to improve members' well-being.

ACs play a significant role in providing credit to low-income people. In Thailand, rural credit is served by formal, semi-formal, and informal financial institutions. BAAC is the major credit providers for agricultural households. The poor cannot access BAAC credit since borrowing from BAAC requires collateral. Hence, households without collateral seek an alternative source of credit such as ACs, the Village Fund, and informal providers. Amount of AC loans have continuously increased. The major AC loans are short-term loans which are used for emergency needs and production expenses.

Furthermore, ACs assist members to access agricultural product markets. AC marketing services assist farmers in reducing transaction costs and increasing their bargaining power in the market. However, farmers do not always trade through ACs because they often lack efficient management and infrastructure. The share of agricultural products traded through the AC channel to total domestic agricultural products is less than 20%. The volume of AC marketing is dominated by three products; para-rubber, raw milk, and paddy.

Under an open market economy, ACs confront several challenges such as increasing diversification of members and changes in consumer preferences. Members need different services but ACs have limited resources. Moreover, ACs rely on government support, thus their policies and programs are top-down policies designed by the government. Therefore, most of Thai ACs cannot operate efficiently to respond to their members' needs and have low member participation. On account of these challenges, there are only a few successful ACs in Thailand such as the KAC, the PFC, the GNC, and the Tha-Yang Cooperative Ltd. The successful ACs create new innovations or strategies (e.g. collaboration with Private Companies, product quality development, E-commerce, and network creation) to ensure business sustainability. New strategies not only contribute to ACs' performance but also assist their members in gaining market competitiveness.

Chapter 3

Review of the Literature

This chapter reviews the literature on credit and non-credit support services, focusing on the determinants for AC participation and the effects of AC participation on rural household welfare. This chapter consists of three sections. Section 3.1 reviews relevant theories on credit and non-credit support services. The following section reviews the empirical research on households' decisions to participate in credit and non-credit support services. Section 3.2 reviews models and determinants of household participation in both credit and non-credit services. Non-credit support services include marketing and agricultural extension services. Lastly, Section 3.3 examines the effects of AC participation on household welfare. This section includes information about impact evaluation methodologies and the effects of agricultural cooperatives at a household level.

3.1 Theory of Household Demand and Credit Rationing

This section discusses relevant theories to household participation in credit and marketing services. Based on the demand theory, agricultural household demand models have been developed to explain household's decision to participate in credit and marketing services. Household demand theory explains household behaviour which is demand side. However, because of credit market imperfection, some individuals are constrained to access credit. Credit rationing theory explains credit availability in credit market.

3.1.1 Household Demand for Credit

The demand theory for credit illustrates the relationship between household participation in AC credit and the factors influencing the participation. The household model for credit demand presented in this study is applied to analyse the determinants of household participation in AC credit. Iqbal (1983, 1986) and Swain (2007) developed the agricultural household model for credit based on demand theory. The model can be used to capture farm households' borrowing behaviour. Borrowing helps households to adjust their consumption over time. To capture borrowing, the household demand framework applies a multi-period utility function. For convenience, the model is assumed to have two periods. Households seek utility maximization by choosing the optimal level of products (C_t) and leisure (L_t). Households have an initial endowment (K) for farm production and given household characteristics (Z). The household utility function can be shown as:

$$U = f(C_1, C_2, L_1, L_2; Z) \quad (3.1)$$

The time subscript 1 refers to the current period in which borrowing occurs. The time subscript 2 refers to the future period, during which the household repays the loan. Income and time constraints for each period are shown in equations (3.2) to (3.5). Households produce farm outputs using household labour and initial farm endowments (K_t) (Swain, 2007). Households earn income from farm product sales ($P_t f(K_t, H_t)$) with their labour to the market. If the household labour (T) is more than the labour needed for their farm production (H_t), the households work on off-farm activities (M_t). In this case, the household income includes wages from working on off-farm activities ($W_1 M_1$). The model assumes output price (P_t) and labour wage (W_t) are exogenous. Credit raises household income in the current period and is repaid in the future period ($t=2$). Therefore, the household income in the current period includes income from the farm, wages from off-farm work, and the loan amount (B) (shown on the left hand side of equation 3.2). They spend their incomes on consumption (C_t) and farm investment (I) (shown on the right hand side of equation 3.2).

$$P_1 f(K_1, H_1) + W_1 M_1 + B = C_1 + I \quad (3.2)$$

$$P_2 \alpha f(K_2, H_2) + W_2 M_2 = C_2 + B(1+r) \quad (3.3)$$

$$M_1 = T - L_1 - H_1 \quad (3.4)$$

$$M_2 = T - L_2 - H_2 \quad (3.5)$$

Where C is consumption expense; L is leisure; I is a farm investment where $K_2 = K_1 + I$; r is a loan interest rate; α is a parameter of technical improvement. Investment in farm technology raises household income in the subsequent periods because implementing new farm technology increases farm productivity (Feder, Just, & Zilberman, 1985; Singh, Squire, & Strauss, 1986). This effect is captured in the model by a parameter of technical improvement (α). For the subsequent period, the households obtain increased farm incomes ($P_2 \alpha f(K_2, H_2)$) and wages from off-farm activities ($W_2 M_2$). However, the households need to pay back the loan with interest ($B(1+r)$). The income constraint for this period is shown in equation (3.3). Equations (3.4) and (3.5) present the household time constraints in the current and future periods, respectively.

As a result of farm households' dual roles, their production and consumption are related. This implies that households have to make a decision to allocate their resources for production and consumption simultaneously. The optimal consumption, leisure, and loan amount can be derived from the household demand model (equations 3.1 to 3.5) using the Lagrangian multiplier approach. The Lagrangian equation is given as:

$$L = U(C_1, C_2, L_1, L_2) + \lambda_1 (P_1 f(K_1, H_1) + W_1 M_1 + B - C_1 - I) + \lambda_2 (P_2 \alpha f(K_2, H_2) + W_2 M_2 - C_2 - B(1+r)) + \lambda_3 (M_1 - T + L_1 + H_1) + \lambda_4 (M_2 - T + L_2 + H_2) \quad (3.6)$$

Solutions for optimal consumption expense (C_1 and C_2), level of leisure (L_1 and L_2), and loan amount that household need can be identified using the first order condition. After solving these equations, we obtain the loan amount which is a function of farm endowments, the difference between input price and output price, the interest rate, and household characteristics. The agricultural household model for credit demand yields a set of credit demand determinants. The model is employed as a benchmark to analyse the determinants of household participation in AC credit in our study. Since data used in the analysis is cross-sectional and prices do not vary significantly across districts, input and output prices are constant across farm households. Thus these prices are excluded from the model (Arthur & van Kooten, 1985).

3.1.2 Credit Rationing Theory

Stiglitz and Weiss' (1981) theory of credit markets attempts to explain credit rationing in the credit markets. The theory explains why some borrowers are able to obtain loans from markets but others cannot. Agency problems such as asymmetric information and moral hazard impact on credit availability since they are sources of credit risk (Mishkin, 2007). According to Stiglitz and Weiss (1981), market imperfection creates credit rationing and limits credit access for borrowers.

The credit markets are based on imperfect information. Borrowers have more information than lenders about the probability of the success of their projects or whether they will spend their loans on the intended projects. Borrowers can be divided into different categories, based on their ability to pay back loans; high (good borrowers) and low probability (bad borrowers). Lenders cannot clearly identify types of borrowers, since they do not have access to borrowers' key information, such as a borrower's capacity to repay a loan or the riskiness of projects that the borrower intend to spend the loan on.

Asymmetric information influences lenders' decisions to approve loans. Lenders use interest rates to cover the risk of default (Quach, 2005). However, using interest rates results in two problems; adverse selection and the moral hazard problem. Adverse selection arises in the credit market since some borrowers are unlikely to repay their loans; credit providers cannot identify good borrowers from bad borrowers. Lenders offer the same interest rates to borrowers. Due to asymmetry information, lenders increase interest rate to cover credit risk. Higher interest rates means that only riskier borrowers will apply for loans (Stiglitz & Weiss, 1981; Zeller, 1994). When credit is constrained, high risk borrowers are often willing to pay a higher interest rate to accept loans (Feder, Lau, Lin, & Luo, 1990). This means that borrowers are more likely to be riskier, which may reduce the lender's

profits (Stiglitz & Weiss, 1981). Moreover, high interest rates encourage borrowers to invest in riskier projects (Stiglitz & Weiss, 1981). The interest rate is a cost; thus, it influences borrowers' behaviour. Increased interest rates mean that borrowers are more likely to invest loans in riskier projects, which have a lower probability of success but high rates of return (Zeller, 1994).

Raising the interest rate does not always lead to greater profits for lenders. As explained above, higher interest rates tends to lead to more riskier borrowers in the market (Freixas & Rochet, 2008; Stiglitz & Weiss, 1981). Providing loans at a higher interest rate may lower lender's returns since such loans are likely to entail higher risk and increase the riskiness of the average loan. Therefore, lenders prefer credit rationing over increasing interest rates (Stiglitz & Weiss, 1981). However, the signalling process can solve information asymmetries and the credit rationing problem (Milde & Riley, 1988; Steijvers & Voordeckers, 2009). Signalling implementation allows lenders to distinguish low risk borrowers from high risk borrowers without withdrawing low risk borrowers from the market (Milde & Riley, 1988). Signalling transfers loan applicants' characteristics to lenders so that they can assess borrowers' quality/types. A multiple-contract is offered by lenders to separate out high and low quality borrowers (Milde & Riley, 1988). Lenders exploit various conditions in the contracts to signal borrowers' type, such as different interest rates, loan size, collateral requirements, and loan maturities.

Interest rate is an important variable to identify different types of borrowers (Stiglitz & Weiss, 1981). Lenders use interest rates and collateral as screening devices to separate types of borrowers (Cressy & Toivanen, 2001; Stiglitz & Weiss, 1981). Lenders propose different contracts; contract with higher interest rates but with low collateral and vice versa. Good borrowers will choose to provide collateral and a pay lower interest rate. In contrast, the bad borrowers who know that they have a high probability of default will choose a contract with low collateral and pay higher interest rates. Bad borrowers do not choose contracts designed for good borrowers since they are afraid that they will lose their collateral.

Lenders offer borrowers different loan sizes and interest rates as a way to solve information asymmetries (Milde & Riley, 1988). Project characteristics are important factors which help determine loan size. Borrowers' expected returns are assumed to increase with loan size (Milde & Riley, 1988). Lenders are able to screen borrowers' loan quality by offering various loan sizes, with different interest rates. Lenders offer larger loans with higher interest rates. Borrowers signal their risk by selecting the size of the loan. The relationship between loan size and borrowers' loan quality can occur in two ways. First, applicants' loan quality and loan size have a positive correlation. Borrowers with higher quality projects tend to select larger loans rather than smaller ones. Borrowers' returns depend on the quality of the projects they invest in. Borrowers with high quality

of projects who obtain a larger loan will receive a higher return from their projects. Thus they are more willing to borrow a greater amount of money than borrowers who intend to invest in a low quality project (Milde & Riley, 1988). To receive a larger loans, applicants with higher quality projects (lower risk) are willing to pay a higher interest rate. Selecting a larger loan with a higher interest rate implies that they are high quality applicants. However, loan size signalling may have a negative relationship with borrowers' loan quality (Milde & Riley, 1988). If borrowers' return function does not increase with loan size, borrowers with high quality projects will pay a lower interest rate. Thus they will accept a smaller loan. In this situation, high quality borrowers signal their status by choosing a smaller loan with a lower interest rate.

Collateral provision can mitigate informational asymmetries and solve credit rationing by screening borrowers' risks (Steijvers & Voordeckers, 2009). Collateral has a positive relationship with borrower quality. Low risk borrowers are more likely to provide more collateral to signal that they are good borrowers (Bester, 1987; Chan & Kanatas, 1985). In contrast, collateral can be negatively associated with borrowers' quality. High-risk borrowers may provide more collateral than low-risk borrowers (Mishkin, 2007; Steijvers & Voordeckers, 2009). Lenders require high collateral for high-risk borrowers to prevent them from changing their behaviour. Loan maturity is applied as a signalling instrument to reduce the information asymmetries (Steijvers & Voordeckers, 2009). Selecting short-term loans signals to lenders that borrowers' projects are good quality. Thus they signal to lenders that their projects will earn high returns and therefore they will be able to repay their loans in a short amount of time.

Raising the interest rate is not an effective way for resolving informational asymmetries since it increases borrowers' risks and reduces lenders' returns. Instead, credit rationing is often the result. To resolve information asymmetries and credit rationing, the signalling process is used to distinguish types of borrowers. Lenders offer contracts with different condition for each loan application. Therefore, loan attributes may influence the size of the loan granted by lenders. Our study thus includes loan attributes as one set of factors which influence loan size.

Model of Credit Rationing

The presence of credit rationing can be shown by the model of ex-ante asymmetric information. Quach (2005) developed a model to capture credit rationing in the credit market. The model consists of two agents; borrowers and lenders. Borrowers lack capital meaning they need to borrow money for investing in project i . Lenders providing loans to borrowers aim to maximize their profit.

Under the imperfect information in the credit market, it can be assumed that the expected return of every project (μ_i) is equal, however, the probability of success (ρ_i) is different (Quach, 2005). The

expected return of successful and failed projects are denoted by μ_i^s , μ_i^f respectively. Lenders can identify the expected return of projects but not the probability of the project's success. With the same project expected return, borrowers are offered the same interest rate (r) and loan amount (B).

The model assumes that the expected return, when the project success is greater than the loan repayment, $\mu_i^s \geq (1+r)B$. If the return of the failed project is less than the loan repayment then $\mu_i^f < (1+r)B$. The expected return to the projects and to the borrowers is given as:

$$\mu_i = \rho_i \mu_i^s + (1 - \rho_i) \mu_i^f \quad (3.7)$$

$$\pi(\rho_i, r) = \rho_i [\mu_i^s - (1+r)B] \quad (3.8)$$

Substituting equation (3.7) into equation (3.8), and rearranging, we get:

$$\pi(\rho_i, r) = \mu_i - \mu_i^f + \rho_i [\mu_i^f - (1+r)B] \quad (3.9)$$

The relationship between the probability of success and the borrower's expected return is illustrated by the first order condition:

$$\partial \pi(\rho_i, r) / \partial \rho_i = \mu_i^f - (1+r)B \quad (3.10)$$

Based on the assumption that the expected return of failure is less than the loan repayment, the impact of the probability of success on the borrower's expected return is lower than zero:

$\mu_i^f - (1+r)B < 0$. Therefore, the borrower's expected return is the decreasing function of the probability of success.

To illustrate the relationship between the probability of success and the interest rate, the implicit function theorem is applied to differentiate r with respect to ρ_i , we get

$$\frac{\partial r}{\partial \rho_i} = - \frac{\partial \pi(\rho_i, r) / \partial \rho_i}{\partial \pi(\rho_i, r) / \partial r} < 0 \quad (3.11)$$

Since $\partial \pi(\rho_i, r) / \partial \rho_i < 0$, thus $\partial \pi(\rho_i, r) / \partial r < 0$. Equation (3.11) implies that an increased interest rate decreases the probability of success. This means that the higher interest rate leads borrowers with lower risk projects to withdraw from the credit market. In short, the remaining borrowers tend to invest in riskier projects.

In terms of the lenders' perspective, this assumes that lenders will receive full repayment, if the borrower's project is successful. If the project fails, the borrower will pay back the loan, as much as he or she gains from the project. The lender expected return is given as:

$$K(\rho_i, r) = \rho_i(1+r)B + (1-\rho_i)\mu_i^f = \rho_i[(1+r)B - \mu_i^f] \quad (3.12)$$

The relationship between the probability of success and the lender's return is shown in equation (3.13)

$$\partial K(\rho_i, r) / \partial \rho_i = (1+r)B - \mu_i^f \quad (3.13)$$

Since $(1+r)B > \mu_i^f$, the lender expected return is an increasing function of the probability of success. The increasing interest rate results in two effects on the lender expected return. First, the lender return increases because of the increase in interest income which is the value of the term $(1+r)B - \mu_i^f$. Second, based on the relationship between the probability of success and the interest rate, the increased interest rate decreases the probability of success. This makes the lower risk borrowers withdraw from the market, thus the lender expected return decreases (see equation 3.13).

The relationship between the lender expected return, the interest rate and the presence of credit rationing is shown in Figure 3.1 (Quach, 2005). The lender-optimal interest rate (r^*) is the interest rate that maximizes the lender expected return. At a certain interest rate (r_1) which is lower than the lender-optimal interest rate, the credit demand exceeds supply (see Figure 3.1). When r is less than (r^*), the increase in interest rate raises the expected return of the lender, hence, the lender increases the interest rate without leading to a withdrawal of low risk borrowers. However, if the lender keeps increasing the interest rate to match the supply and demand, this situation may lead to a decrease in the lender expected returns. At higher interest rates, which is higher than the lender-optimal interest rate, such as at r_2 , low risk borrowers withdraw from the credit market. This situation means that average loans have a higher risk for the lender. As a result, the expected return of the lender decreases. Therefore, the lender prefers to offer interest at r^* and ration credit at r^* .

Credit rationing theory is useful to explain why some individuals is constrained to access credit. Credit rationing theory suggests that the loan amount granted by lenders depends not only on credit applications decisions but also lenders' decisions (Quach, 2005). Because of the existence of excessive credit demand, raising interest rates does not provide lenders a viable solution to cover default risks. Increased interest rates tend to increase borrowers' risks and decrease lenders' returns (Stiglitz & Weiss, 1981). In times of excessive credit demands, it is better for lenders to ration credit.

Since the rural credit markets in our study are characterised by excessive credit demand, the empirical model for analysing AC loan amount determinants is based on credit rationing. The empirical model includes both household characteristics and credit attributes to analyse loan amount.

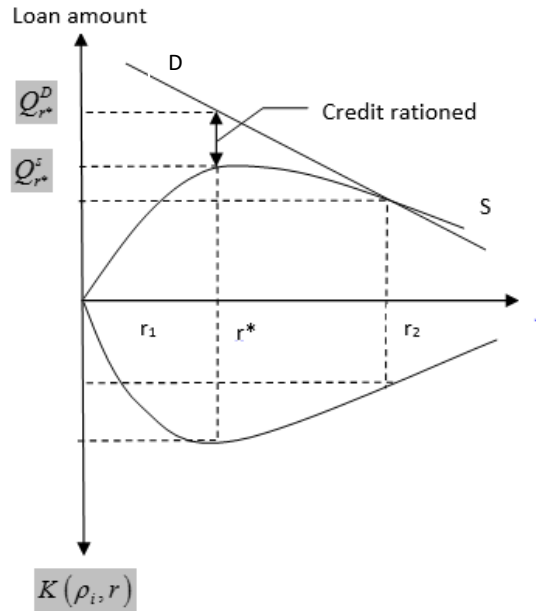


Figure 3.1 Presence of Credit Rationing

Source: adapted from Quach, 2005

3.1.3 Agricultural Household Demand for Marketing Services

The framework applied to analyse household decisions to participate in the market is based on the concept of transaction costs (Key, Sadoulet & Janvry, 2000). Transaction costs are defined as cost related to market transactions (Key et al., 2000). Since transaction costs increase prices for consumers and decrease producers' net returns, households' decisions to trade through markets depends on transaction costs (Barrett, 2008; Goetz, 1992; Key et al., 2000).

Goetz (1992) in sub-Saharan Africa and Key et al. (2000) in Mexico use the transaction costs framework to analyse the relationship between transaction costs and household decisions to participate in the agricultural markets. The model assumes that the decision to participate is a two-step process. In the first stage, households decide whether to trade in the market and which position to adopt; as a buyer or a seller. In the second stage, the participants decide the amount of product traded through the market. The probability of participation in the market and the level of market participation are estimated separately.

Based on Key et al.'s (2000) model, household utility is a function of goods and services consumed. This is given as follows:

$$U = (C; Z_u) \quad (3.14)$$

U is the function of household utility, assumed to be monotone; increasing in arguments, strictly concave, and possessing continuous second partial derivatives (Ouma, Jagwe, Obare, & Abele, 2010). C is the set of goods and service consumed. Z_u is the exogenous household characteristics affecting household utility.

Households make decisions about their total outputs (q_i). Products are allocated in the following manner; for family consumption (C_i), sale through the market (m_i), and use as input (x_i). The households have two choices to participate in the market as a seller or a buyer. The households maximize their utility function and face three constraints; a cash constraint (equation 3.15), farm production (equation 3.16), resource balance constraint (equation 3.17), presented below;

$$\sum_{i=1}^N \left[\left(p_i^m - t_{pi}^s(Z_t^s) \right) \delta_i^s + \left(p_i^m + t_{pi}^b(Z_t^b) \right) \delta_i^b \right] m_i - t_{fi}^s(Z_t^s) \delta_i^s - t_{fi}^b(Z_t^b) \delta_i^b + T = 0 \quad (3.15)$$

$$G(q_i, x_i; Z_q) = 0 \quad (3.16)$$

$$q_i - x_i + A_i - m_i - C_i = 0 \quad , i = 1, 2, 3, \dots, N \quad (3.17)$$

$$C_i, q_i, x_i \geq 0 \quad (3.18)$$

Where Z_q is the exogenous household characteristics affecting his/her production, including land and location factors, such as population density and market access (Ouma, Jagwe, Obare, & Abele, 2010). A_i is the household's endowment in good i ; G stands for production technology; x_i is the input, including purchased and non-purchased input for the production of good i ; q_i is the amount of product i produced by the household. p_i^m is the market price of good i ; m_i is the amount of good i traded via the market. m_i is positive if the household chooses to participate in the market as a seller. It is negative when the household is a buyer. δ_i^s, δ_i^b represent a household's decision to participate in the market. δ_i^s equals one, if m_i is positive and zero otherwise. δ_i^b equals one, if m_i is negative and zero otherwise. t_{pi}^s, t_{pi}^b denote the proportional transaction cost per unit of output i sold or purchased via the market, respectively; t_{fi}^s, t_{fi}^b is the fixed transaction cost for selling and purchasing good i via the market, respectively.

Cash constraint (equation 3.15) shows that the households cannot spend money to purchase goods beyond their total income. The first term on the left-hand side of the cash constraint equation presents the net revenue from trade at the market. The proportion transaction costs (PTCs) influence the price received by a household. It decreases the price received by the seller, while it increases the price paid by the buyer. PTCs consist of costs for transportation and market access which are unobservable. While it is difficult to measure the value of transportation and time spent in the market by farmers, PTCs can be observed as a function of exogenous factors affecting PTCs (Z_t^s, Z_t^b). The second and third terms are the fixed transaction costs (FTCs) for market participation. Although FTCs are unobserved, the FTCs are perceived as the function of exogenous characteristics (Z_t^s, Z_t^b) affecting the FTCs for selling and buying, respectively. When the households are sellers, they pay the fixed cost t_{fi}^s and pay t_{fi}^b for the buyers. The last term (T) is transfer payment and includes other income.

In addition to cash budget constraints, the household faces constraint relating to resource balancing. This is shown in equation (3.17). The resource balance constraint shows that the summation of amount of good i consumed (C_i), used as input (x_i), and sold ($m_i > 0$) is equal to the summation of an endowment for good i (A_i) and the amount of good i produced (q_i) and bought from the market ($m_i < 0$).

Farm production technologies are included in equation (3.16). They affect input (x_i) and output (q_i). The equation assumes the production technology is an increasing and concave function. A unit increase in input generates an increase in output. However, the rate of output decreases with increased input. Lastly, the equation assumes that households face a non-negativity constraint, as presented in equation (3.18). The amount of good i produced, used as input, or consumed by households may be equal to zero in a given production cycle or positive, but not less than zero.

The households decide whether to participate in the market or not. If they participate in the market, they will choose the amount of product traded via the market to maximize their utility, subject to cash, resources balance, and production technology constraints. This can be rewritten as follows:

$$L = U(C_i; Z_u) + \sum_{i=1}^n \lambda_1 (q_i - x_i + A_i - m_i - C_i) + \lambda_2 \left(G(q_i, x_i; Z_q) \right) + \lambda_3 \left[\sum_{i=1}^N \left[\left(p_i^m - t_{pi}^s(Z_t^s) \right) \delta_i^s + \left(p_i^m + t_{pi}^b(Z_t^b) \right) \delta_i^b \right] m_i - t_{fi}^s(Z_t^s) \delta_i^s - t_{fi}^b(Z_t^b) \delta_i^b + T \right] \quad (3.19)$$

Where λ_i is the Lagrangian multiplier. The optimal solution can be broken down into two steps. The first step involves solving the optimal solution for the decision to participate in the market. The second step involves solving amount of good i produced, used as input, and consumed. The optimal

solution can be solved by the first order condition with respect to amount of goods for consumption (C_i), amount of outputs (q_i), amount of inputs (x_i); and amount of good for trade in markets (m_i).

After solving the first order condition equations, we obtain the decision price (p_i) is defined as:

$$p_i = \begin{cases} p_i^m - t_{pi}^s & \text{if } m_i > 0, \text{ seller} \\ p_i^m + t_{pi}^b & \text{if } m_i < 0, \text{ buyer} \\ \tilde{p}_i = \frac{\lambda_1}{\lambda_3} & \text{if } m_i = 0, \text{ self-sufficient} \end{cases} \quad (3.20)$$

When the households participate in the market, price is influenced by PTCs. However, if the households do not participate in the market, price is an unobservable internal shadow price (\tilde{p}_i) (Key et al., 2000).

Based on the transaction costs, the household decisions to participate in the market is a choice decision. The households have to decide whether to participate in the market as a seller or buyer or not at all (and be self-sufficient). This assumes that the households weigh the expected utility among three choices and choose one which provides them with the highest utility. The expected utility of the three choices (buyer, seller, self-sufficient) is represented in the function of price decision. The utility levels under the three different choices can be rewritten in the form of the indirect utility function (see Equation 3.21). $V(p_i, y, Z_u)$ is an indirect utility function. p_i is the decision price; $y_0(p_i)$ is household income before the occurrence of the FTCs.

$$\begin{aligned} V^s &= V_i \left((p_i^m - t_{pi}^s), y_0(p_i^m - t_{pi}^s) - t_{fi}^s, Z_u \right) \text{if } \textit{sellers} \\ V^b &= V_i \left((p_i^m + t_{pi}^b), y_0(p_i^m + t_{pi}^b) - t_{fi}^b, Z_u \right) \text{if } \textit{buyers} \\ V^a &= V_i(p_i, y_0(p_i), Z_u) \text{if } \textit{self-sufficient households} \end{aligned} \quad (3.21)$$

The FTCs and PTCs influence the household decision to participate in the market. The increased FTCs reduce the household income and utility (see equations 3.21). The household's decision to participate in the market depends on the market price (p_i^m). If the market price is in the range of $p_i - t_{pi}^s$ and $p_i + t_{pi}^s$ that is, $(p_i - t_{pi}^b < p_i^m < p_i + t_{pi}^s)$, the households decide not to participate in the market. If market prices are less than $p_i - t_{pi}^b$, the households may choose to participate in the market as buyers. In contrast, they will be sellers if the market price is greater than $p_i + t_{pi}^s$.

Household supply of farm products relies on the market price. The supply function is $q(p_i^m, Z_p)$.

With FTCs and PTCs, supply function can be expressed as equation 3.22). Household supply is not influenced by the FTCs, whereas the PTCs affect households who are sellers and buyers in different ways. When the PTCs increase, households who are sellers will decrease their supply to market, while buyers will buy more products through the market.

$$\begin{aligned} q_i^s &= q_i(p_i^m - t_{pi}^s, Z_p) \text{ if } \textit{sellers} \\ q_i^b &= q_i(p_i^m + t_{pi}^b, Z_p) \text{ if } \textit{buyers} \\ q^a &= V_i(p_i, Z_p) \text{ if } \textit{self-sufficient households} \end{aligned} \quad (3.22)$$

Key et al.'s (2000) market participation model includes transaction costs and their effect on households' market participation in terms of the decision to participate in markets and the quantity of products sold in the markets. The households' decision to participate in the markets are determined by household characteristics, which affect their production (Z), the FTCs, and the PTCs. While sale amount is influenced by household characteristics and the PTCs. In our study, the empirical model to investigate the households' decisions to participate in AC marketing services are based on Key et al.'s (2000) model. Transaction costs included in the model are measured by distance to the market, while district dummy variables refer to market accessibility.

3.2 Participation in Credit and Non-Credit Support Service

This section reviews empirical studies on participation in credit and non-credit support services. Due to the limited studies on AC credit participation, our study borrows ideas from formal and informal credit accessibility and applies it to the AC credit. It begins with a review of credit studies about models and determinants of credit participation. The models and determinants of participation in non-credit support services are reviewed in the next section. Non-credit support services include input and output marketing and agricultural extension services.

3.2.1 Participation in Credit Services

Credit participation is explained by credit demand theory and the credit rationing. According to Zeller (1994), credit participation is a two sequential decision. Credit demand is applied to analyse households' decision to participate in credit programs. Their decision to participate in a credit program depends on their demand for credit (Zeller, 1994). In a credit market with asymmetric information, both credit demand and credit rationing are needed to explain the loan amounts granted. The total loan amount granted requires negotiation between both the lender and borrower. Credit providers consider and offer the maximum credit to borrowers (credit limit). The credit limit

depends on the household's likelihood of default (Diagne, Zeller, & Sharma, 2000). The borrowers decide how much they want to borrow within a range of credit limits. Therefore, the exact loan amount depends on various factors relating to both the lender and the borrower (Diagne et al., 2000; Feder, Lau, Lin, & Luo, 1990; Nguyen, 2007; Zeller, 1994).

Previous studies have noted the existence of credit rationing (Feder et al., 1990; Zeller, 1994). Feder et al. (1990) examine the effects of credit on farm production in North-eastern China. They take into account the credit liquidity constraint in their model. They find that approximately 37% of farm households are constrained by credit limitations. Some applicants obtain loans less than for what they had applied, while others had their loans rejected. In short, the total amount of credit requested by borrowers is more than the number of loans offered by credit providers. Zeller (1994) examines the determinants of credit rationing based on data from Madagascar. Zeller shows that both formal and informal credit lenders in Madagascar ration credit. The author's findings show that 51% of formal credit applicants and 23.5% of informal credit applicants do not obtain loan.

Discrete choice theory is applied to analyse household's decision to participate in the credit market. Empirical studies on the determinants of credit participation can be divided into two main streams. First, some studies explore household decisions to participate in credit programs. Since household decision to participate in the credit program is a simple yes or no, a binary choice model can be applied to estimate the probability of credit participation and the determinants affecting credit participation (Tetteh Anang, Sipilainen, Backman, & Kola, 2015). The probit and logit models are normally used in this stream of research. For example, Ololade and Olagunju (2013) use a logit model to identify the impact of household characteristics and credit conditions on rural farmers' credit accessibility in Nigeria. The authors focus on the effects of credit conditions on credit access, thus their model includes household characteristics, credit attributes, such as collateral or guarantee availability and interest rates, and other factors such as region dummy variables and access to other forms of credit. Fongthong and Suriya (2014) investigate the factors relating to borrowing money from The Village Fund in Thailand. The authors use the logit model to analyse household socioeconomic data from 2009. The authors' study analyses whether The Village Fund serves the poor, which include the poverty index, poverty gap, and an interaction term to measure poverty in the model. Sebopetji and Belete (2009) use the probit model to analyse the influence of household characteristics on farmers' decisions to borrow credit in South Africa. The authors are interested in both concerned with individual and household factors but do not include geographical factors. Nguyen (2007) and Khoi (2012) utilize a probit model to determine the probability of Vietnamese household borrowing. The authors consider the interaction between informal loans and formal credit access. Their formal credit accessibility model includes informal loan as an explanatory variable.

Ololade and Olagunju (2013), Fongthong and Suriya (2014), and Khoi, Gan, Nartea, and Cohen (2013) find that the poor face more credit rationing than other groups and often cannot gain access to credit. Collateral is a key factor which restricts low-income households from participating in credit programs (Ololade & Olagunju, 2013; Sebopetji & Belete, 2009). Forming a group, such as a cooperative, enables low-income households to borrow from formal credit providers. Group lending mechanisms can solve the problem of collateral scarcity and creditworthiness since it mitigates asymmetric information and the moral hazard problem (Coleman, 1999; Sebopetji & Belete, 2009). It overcomes informational asymmetries since members know other members' information. When members borrow money, they self-select members in the group, co-guarantee each other's loans, and monitor each other. Group lending provides lenders' with low monitoring costs. Moreover, if the group dynamics and their ability to sanction each other are strong, members will repay their loans on time.

A number of studies have provided insight into households' behaviour in borrowing from different credit sources (Menkhoff & Rungruxsirivorn, 2011; Tsukada, Higashikata, & Takahashi, 2010). In the credit market, credit providers can be classified as formal and informal lenders. Households have different preferences for credit; thus, the different credit sources may serve different borrowers (Tsukada et al., 2010). A multinomial choice model is applied to investigate factors affecting the choice of lenders when the dependent variable includes more than two choices. A multinomial choice model is suitable to explain the likelihood that an individual will choose one program over another (Hill, Griffiths, & Lim, 2011). For example, Menkhoff and Rungruxsirivorn (2011) explore the determinants of households' decision to participate in different credit providers in Thailand. They group the choice of credit providers into seven choices and apply a multinomial logit model using the Village Fund as a benchmark. Similarly, Tsukada et al. (2010) investigate factors affecting borrowing from six different credit sources in Indonesia using a mixed multinomial logit model. They conclude that credit market consists of different types of providers and each serve different borrowers. In short, informal credit providers are more attractive to low-income households than formal credit providers. In addition, the coexistence of different credit sectors reduces credit constraints.

Another stream of studies on credit participation focuses on the determinants of loan size. Duong and Izumida (2002), Khoi et al. (2013), and Nguyen (2007) attempt to capture credit rationing among different credit providers. Due to asymmetric information in the rural credit market, borrowers face credit constraints. The credit applicants' loan may be rejected or granted. If borrowers obtain loans, they may get the full or a partial amount of the loan requested. Since there are several credit providers, borrowers may choose to borrow from one credit provider or from many lenders at the same time (Duong & Izumida, 2002). For example, Duong and Izumida (2002) compare the determinants of loan amount between formal and informal credit programs in Vietnam. The authors

divide the sample into two groups; formal and informal borrowers. The authors use the Tobit model to estimate determinants of formal and informal loan amounts. They consider only factors of demand side; individual and household characteristics and province dummy. Their findings show that the formal loan amount is positively influenced by farm size and livestock value, while informal loan amount is positively affected by farm size and the dependent ratio at the 1% level. Similarly, Nguyen (2007) uses the Tobit model to identify the determinants of rural households' loan size in Vietnam. The author uses Household data from the Vietnamese Living Standard Survey (VLSS) 1997/98. The results show that loan amount has a negative relationship with age, but a positive relationship with the size of the land at the 1% level. The findings of this stream contribute to understanding the factors which affect the loan amount under conditions of credit rationing. Loan amount is influenced by individual and household characteristics (e.g. age, education, family members, landholding) and geographical factors such as region dummy and distance to the nearest market.

Besides capturing the coexistence of different credit providers, some studies argued that selection bias may take place in credit participation analysis. As a two sequential decision (Zeller, 1994), selection bias may happen in the second step of a credit decision; the process of deciding the total loan amount. At the first stage, households decide whether to borrow loans or not. The second stage is called the outcome stage; only households who decide to borrow loans will need to decide how much to borrow. The second stage of the credit decision may have a selection bias since the loan amount estimation considers only data from credit participants. Moreover, credit participation is not random. Households self-select; in other words, they decide to borrow money. There may be some observable and non-observable characteristics which influence households to participate in credit. Therefore, using information from only credit participants to estimate the loan amount may lead to a selection bias. A study which ignores selection bias may be biased (Girma & Abebaw, 2015; Tetteh Anang et al., 2015). Selection bias can be controlled using the Heckman selection model.

Zeller (1994) is one of the pioneers who provides a framework to analyse credit rationing by taking into account the selection bias. The author investigates the determinants of credit access and credit rationing under the coexistence of both formal and informal credit providers. Credit decision is a sequential decision process of borrowers and lenders. First, credit applicants decide to apply for credit. In the second step, lenders decide amount of loans granted. Credit rationing is the decision of lenders after households apply for credits. The determinants of credit participation and credit rationing are estimated separately between credit equations of formal and informal providers, using the Heckman two-step model. The credit rationing equation is estimated simultaneously alongside the credit participation equation.

Zeller (1994) finds that low-income individuals have limited access to formal credit providers. The poor cannot borrow formal loans because they are more likely to default on their loans. However, a lack of collateral can be solved by group lending. In Madagascar, poor individuals who have no collateral can access formal credit facilities by borrowing through community-based groups. Members in the group have information about their members' credit worthiness than formal lenders. Thus formal lenders use applicants' information and social networks to mitigate information asymmetry (Zeller, 1994). Regarding informal credit access, the author finds that the poor are less likely to be able to access formal credit and have to rely heavily on informal sources for consumption purposes. The probability of access to informal credit is greatly influenced by an individuals' social network. Having many friends or relatives makes it easier to ask them for loans. This is also true for AC credit access. Under collateral-free, having lots of friends who are AC members enables households to access AC credits due to co-guarantee. Empirical studies show that the more neighbours involve in ACs, the more likely are farmers to participate in ACs (Ito et al., 2012; Ma & Abdulai, 2016).

Khoi et al. (2013) and Duy, D'Haese, Lemba, and D'Haese (2012) both explore the factors influencing credit participation. Both studies consider the credit participation decision as a two sequential decision and take into account the selection bias. Duy et al. (2012) compares the impact of individual lending with group-based lending on households' formal credit accessibility in the Mekong Delta, in Vietnam. The Heckman selection model is applied to control for selection bias. In the first step of the Heckman model, the probit model is applied to estimate the probability of credit access. In the second step, the loan size equation is estimated. Duy et al. (2012) find that selection bias does not affect households' decisions to borrow money. Household endowments, particularly land, determine credit access and loan amount for individual lending. Clearly access to formal credit requires collateral. Collateral requirements means that the very poor are not able to access formal credit. In contrast, social capital is significant for the group-based lending. Households who have more social capital tend to borrow larger loan. Duy's result shows that group-based lending helps the poor to overcome a lack of collateral. Members of group self-select themselves, employ social sanctions, and monitor their behaviours, thus group lending can mitigate the risk of default.

Khoi et al. (2013) attempt to capture the coexistence of formal and informal providers. The authors assume that formal credit accessibility is influenced by informal loans which are an endogenous variable. Therefore, formal and informal loans are estimated using a system of simultaneous equations. Khoi et al. (2013) use the Heckman two-step model to control for the selection bias problem. In the first step of the Heckman model, the probability of formal credit access is estimated using the probit endogenous model. In the second step, the loan size equation is estimated. Khoi et al. reveal the presence of a selection bias in their model. Their results show that the lowest income

individuals face greater degrees of credit rationing than other groups and that the poorest of the poor cannot reach formal credits in Vietnam. Social capital such as working with a local government, membership in a credit group, and being a poor household influence household access to formal credit institutions. Moreover, they find that informal loans positively affect accessibility to formal credit. Therefore, ignoring the interaction between informal loans and formal credit accessibility may lead to a biased result.

Our study investigates households' decision to participate in AC credit, both in terms of the decision to participate in AC credit schemes and the loan amount granted. Several studies focus on determinants of household decisions to participate in the credit market (Akerle & Akanni, 2014; Fongthong & Suriya, 2014; Menkhoff & Rungruxsirivorn, 2011; Oloade & Olagunju, 2013; Tsukada et al., 2010). These studies explain households' participation in formal and informal credit programs. However, it is not enough to explain loan amount granted. Credit rationing occurs due to excessive demands for credit and asymmetric information. Under condition of credit rationing, loan amount is determined by both the borrowers and lenders. Hence, understanding the factors which influence loan amount is important to motivate households to participate more in AC credit schemes. Furthermore, there may be a selection bias in the credit decision. Ignoring the selection bias may lead to biased results. Our study considers that households' credit decision is a two sequential decision and takes into account the selection bias. We investigate the determinants of credit participation using the Heckman selection model to mitigate the selection bias.

Determinants for Credit Participation

Previous literature shows that households' decision to participate in the credit market is derived from several factors such as household head and household characteristics and geographic factors (Duong & Izumida, 2002; Khoi et al., 2013; Menkhoff & Rungruxsirivorn, 2011; Zeller, 1994). Most of the literature on credit participation focuses on factors on the demand side (Coleman, 2006; Duong & Izumida, 2002; Duy et al., 2012; Nguyen, 2007). As discussed above, credit participation involves negotiation between the borrowers and credit providers; therefore, it covers both demand and supply factors. The crucial factors influencing credit participation, in terms of credit participation decisions and the loan amount are summarized in Table 3.1. These factors are categorized into four factors; household head characteristics, household characteristics, attributes of credit providers, and geographic factors.

Household head characteristics are important factors which explain a borrower's decision to borrow from formal and informal credit providers. Individual characteristics reflect the skill and workability of household heads (Fongthong & Suriya, 2014). Age and education play important roles in credit accessibility. However, there is no agreement on the impact of age and education on credit

participation (Khoi et al., 2013; Nguyen, 2007; Sebopetji & Belete, 2009; Zeller, 1994). Credit providers use age and education levels as criteria to evaluate borrowers' probability of repaying their loans. Age is used to denote work experience, credit management, and responsibility for loan repayment (Girma & Abebaw, 2015; Khoi et al., 2013; Tetteh Anang et al., 2015). Older individuals are expected to have more experience and credit management skills. Therefore, they are more likely to access formal credit programs.

Similarly, the more educated an individual is, the more likely he or she is able to access credit. Since educated people have more ability to obtain credit information and join extension services, they have more opportunities to generate income and hence are more likely to repay their loans (Girma & Abebaw, 2015). In contrast, younger individuals, who have lower levels of education are often unable to access credit from formal institutions and therefore are more likely to borrow from informal credit sources (Menkhoff & Rungruxsirivorn, 2011; Fongthong & Suriya, 2014). Young people with low levels of education have a lower ability to generate income and are less likely to have collateral needed to borrow money from formal lenders. Thus, they are more likely to borrow from informal lenders.

Age and education level may have negative effects on credit participation. Khoi et al. (2013) and Nguyen (2007) find that age has a negative relationship with loan amount. The elderly are more likely to have less credit demands, since they tend to have more assets and land. They often have enough money for farm production. Thus, they often have lower demand for credit (Nguyen, 2007; Sebopetji & Belete, 2009). Similarly, Khoi et al., (2013) find that household head's education negatively influences loan amount for both formal and informal loans. The education variable in their study is a dichotomous variable which equals 1 when households have no education and 0 otherwise. The negative relationship between no education and loan amount indicates that households with no education tend to borrow less (participate less in the credit market), compared to those with higher levels of education.

Another determinant driving credit participation is gender. Previous findings on the impact of gender on credit participation are different. Women are less constrained by some credit programs. Financial institutions (FIs) in some countries, such as Grameen bank in Bangladesh and microfinance bank in Nigeria, are more likely to provide credit to women (Anyiro & Oriaku, 2011; Bernasek, 2003). Women are important factors to success in social development and poverty alleviation (Bernasek, 2003). Women's income are more effects on household well-being than those of men. Furthermore, they are more creditworthy. They also exhibit a higher repayment rate and contribute to agriculture production. Therefore, women are key customers of FIs. For example, Tetteh Anang et al. (2015) show that gender has a negative and significant relationship to credit access in Northern Ghana. They

find that women are more likely to access credit than men. Similarly, Fongthong and Suriya (2014) find that Thai women have a higher probability of being able to borrow loans from the Village Funds at the 10% level. The Village fund committees believe that women have lower credit risks compared to men. The negative result of gender suggests that women are given more opportunities to participate in credit programs. In contrast, Sebopetji and Belete (2009) find that male household heads have a higher likelihood of participating in credit programs than women. This is because men dominate women, control the household resources and make all of the decisions. Similarly, Ololade and Olagunju (2013) present that in sub-Sahara Africa women are less likely to access credit (by 71.3%) compared to men.

Household characteristics are key determinants which influence credit participation. Household characteristics are divided into two groups, factors related to household wealth and farm production. Household wealth can be captured in terms of household income and assets such as land size, number of livestock, and productive assets. Household wealth is a proxy for household economic status and is used by credit providers to measure a household's creditworthiness (Khoi et al., 2013; Tetteh Anang et al., 2015). Therefore, households with greater wealth tend to have greater access to formal credit programs. In contrast, the poor are more likely to access informal credit programs. Similarly, studying credit access of poor household in Thailand, Menkhoff and Rungruxsirivorn (2011), also argue that households with low incomes tend to borrow from village funds or ACs more than the Bank for Agriculture and Agricultural Cooperatives (BAAC) since they have difficulty accessing formal credit.

Assets, such as land and productive assets, influence credit participation in two ways. First, these factors affect the demand for loans. Since land size indicates scale of production, households with larger farms may need more financial capital to purchase farm inputs for their farm production (Duong & Izumida, 2002; Nguyen, 2007; Tetteh Anang et al., 2015). As a result, households with larger farm capital are more likely to borrow more loans compared to those with smaller areas of land. Farm capital refers to capital stock for agricultural production. Farm capital may have a negative or positive effect on credit demand (Tetteh Anang et al., 2015). Large capital endowed households may have a lower demand for credit since they do not need money to purchase new farm capital. However, farm capital may positively influence loan amount because households with large farm capital are more likely to invest in updated farm capital for production improvement. They are more likely to borrow greater amounts of money. Besides, land and farm capital can be used as loan collateral (Tetteh Anang et al., 2015). In terms of lenders, households with little land and farm capital are regarded as poor and risky borrowers, thus FIs are less likely to offer them credit. However, households with large size of land and productive assets exhibit a higher probability to participate in credit than smaller land owners.

Table 3.1 Determinants of Credit Participation

Independent Variables	Credit Accessibility		Loan Amount	
	Formal Credit	Informal Credit	Formal Credit	Informal Credit
<i>Household Head Characteristics</i>				
Age	+/- Khoi et al. (2013), Nguyen (2007), Sebopetji & Belete (2009), Zeller (1994)	+/- Zeller (1994), Fongthong & Suriya (2014), Khoi et al. (2013), Menkhoff & Rungruxsirivorn (2011)	+/- Zeller (1994), Nguyen (2007)	+/- Zeller (1994), Khoi et al. (2013)
Age Square	+/- Zeller (1994), Tetteh Anang et al. (2015), Ololade & Olagunju (2013)	- Zeller (1994)		- Zeller (1994)
Gender		- Fongthong & Suriya (2014)	+ Zeller (1994), Tetteh Anang et al. (2015)	
Education Level	+/- Zeller (1994), Sebopetji & Belete (2009)	- Fongthong & Suriya (2014), Khoi et al. (2013)	+ Zeller (1994), Coleman (2006)	+ Zeller (1994), Khoi et al. (2013)
Marital Status	+ Duy et al. (2012), Khoi et al. (2013)	+ Fongthong & Suriya (2014)		
Primary Occupation	+ Nguyen (2007), Khoi et al. (2013), Girma and Abebaw (2015)	+ Fongthong & Suriya (2014)	- Khoi et al. (2013)	
<i>Household Characteristics</i>				
Family Size	+ Nguyen (2007)	+ Fongthong & Suriya (2014)	+/- Duy et al. (2012), Nguyen (2007), Tetteh Anang et al. (2015)	
Dependency Ratio		- Fongthong & Suriya (2014)		+ Duong & Izumida (2002)
Adult Members/ Income Earners			+ Coleman (2006)	
Landholding Area or Farm Land	+ Nguyen (2007)	+/- Fongthong & Suriya (2014), Menkhoff & Rungruxsirivorn (2011), Khoi et al. (2013)	+ Duong & Izumida (2002), Coleman (2006), Duy et al. (2012), Nguyen (2007)	+ Duong & Izumida (2002), Khoi et al. (2013)

Table 3.1 Determinants of Credit Participation (Cont.)

Independent Variables	Credit Accessibility		Loan Amount	
	Formal Credit	Informal Credit	Formal Credit	Informal Credit
Livestock Owned			+/- Duong & Izumida (2002), Tetteh Anang et al. (2015)	
Productive Assets	+ Tetteh Anang et al. (2015)		+ Tetteh Anang et al. (2015)	
Household Asset Savings		- Khoi et al. (2013)		- Zeller (1994)
Household Income	+ Tetteh Anang et al. (2015), Khoi et al. (2013)	- Fongthong & Suriya (2014), Khoi et al. (2013)		- Khoi et al. (2013)
Access to Other Credit	+ Khoi et al. (2013) - Li et al. (2011)	+ Fongthong & Suriya (2014)		
Access to Agricultural Services	+ Tetteh Anang et al. (2015)			
Technology Adoption			+ Tetteh Anang et al. (2015)	
Membership of Credit Group or Other Organization	+ Khoi et al. (2013)		+ Duy et al. (2012)	
Government Official	+ Khoi et al. (2013)		+ Coleman (2006)	
Poor Household	+ Khoi et al. (2013)			
Credit Attributes				
Credit Purpose		+ Khoi et al. (2013), Menkhoff & Rungruxsirivorn(2011)	+ Khoi et al. (2013)	(+) Khoi et al. (2013)
Collateral or Guarantor Availability	+ Ololade & Olagunju (2013)			
Loan Duration		+ Khoi et al. (2013)		+ Khoi et al. (2013)
Repayment Capacity			+ Zeller (1994)	+ Zeller (1994)
Geographic Factors				
Location (Region Dummy)	+ Khoi et al. (2013), Tetteh Anang et al. (2015)	+ Fongthong & Suriya (2014), Khoi et al. (2013)	+ Duong & Izumida (2002), Khoi et al. (2013)	- Khoi et al. (2013)
Road Access	+ Khoi et al. (2013)			+ Khoi et al. (2013)
Distance to the Nearest Market	- Duy et al. (2012)		- Nguyen (2007)	

The findings of household wealth on credit access vary. Tetteh Anang et al. (2015) and Duy et al. (2012) demonstrate that land size does not significantly determine credit access and loan size, while, farm capital has a significant effect on credit access and loan size at the 10% level. Farm capital covers capital stock for agricultural production. Farmers who have large amounts of capital are more likely to borrow more to invest in new technologies so that they can expand their production. On the other hand, Nguyen (2007) and Duong and Izumida (2002) indicate that land size positively influences Vietnamese households' formal credit access and loan size, since borrowing from formal lenders requires land as collateral. Therefore, households with greater areas of land are more likely to access formal credit. Furthermore, they are wealthier, hence, lenders tend to grant them bigger loans compared to households with smaller size of land. Similarly, in their study of formal lenders in Vietnam, Duong and Izumida (2002) find a positive relationship between loan amount and farm size.

Household size is an indirect indicator for household income and consumption expenditure. Effects of household size on credit access should be considered together with the dependency ratio and the number of income earners in the family (Fongthong & Suriya, 2014; Menkhoff & Rungruxsirivorn, 2011). A large family with several income earners have a higher probability of accessing credit since they can generate more income. Thus they have the capability to pay back the loans (Nguyen, 2007). However, households with a higher number of children, elderly, or disabled members are less likely to borrow from formal lenders. They are more likely to spend loans to take care of family members; therefore, they are less likely to repay their loans.

Some agricultural production factors, such as extension services, technology adoption, and credit use, determine households' decision to participate in credit. These factors positively affect credit participation. Extension services are important sources of market information, farm production knowledge, modern farm material and technology and farm production support. Farmers who have access to extension services have more opportunities to improve their farm production skills and farm input. As a result, farmers are more likely to obtain loans for production expansion (Girma & Abebaw, 2015; Tetteh Anang et al., 2015). Farmers who want to adopt technology may need money to invest in new technology, thus technology adopters are more likely to participate in credit programs (Tetteh Anang et al., 2015).

Previous studies have suggested that loans borrowed from other sources influence households' decisions to participate in credit services (Duong & Izumida, 2002; Fongthong & Suriya, 2014; Khoi et al., 2013). Loans from different sources are complementary. Formal and informal credit coexist in the credit market. Households may borrow from several credit providers at the same time to obtain sufficient capital (Khoi et al., 2013). Credit access from other sources are likely to determine participation in credit programs. Credit from other sources may have a positive effect on households'

demand for credit. Khoi et al. (2013) show that informal loans positively influence households' access to formal credits at the 1% level, indicating that a 1% increase in informal credit raises the probability of formal credit access by 5%. Similarly, Fongthong and Suriya (2014) indicate that accessibility to other loans positively influences households' decisions to borrow credit from Thai Village Fund at the 5% level. This is because formal credit or semi-formal credit (that is, credit from Thai Village Fund and ACs) are cheaper than informal credit schemes. Households borrowing from informal lenders often borrow credit from formal lenders to repay informal loans (Khoi et al., 2013). On the other hand, accessibility to other loans negatively influences households' credit access. From lenders' perspectives, formal lenders apply other loans as justification for rationing credit since other loans can indicate outstanding debt and repayment ability (Li et al., 2011; Zeller, 1994). Households with high loans from other credit sources face a higher probability of being constrained, thus, they are less likely to participate in the credit market. Li et al. (2011) reveal that access to other loans has a negative effect on the probability of credit access at the 1% level. This means that households' probability of credit access will decrease by 10.02% if the household access to other credits.

Previous studies did not critically examine the credit provider characteristics, as key determinants of credit participation. Credit purpose and collateral requirement directly influence credit accessibility (Khoi et al., 2013; Menkhoff & Rungruxsirivorn, 2011; Ololade & Olagunju, 2013; Tsukada et al., 2010). Credit purpose determines household's credit access to formal or informal sources of credit (Menkhoff & Rungruxsirivorn, 2011; Tsukada et al., 2010). Different credit sources serve different credit purposes. For example, in Thailand, BAAC and ACs provide loans for production purposes in the agricultural sector, while loans offered by commercial banks are for production in the non-agricultural sector. Loans from informal lenders are predominantly for consumption. Households who need loans for farm production are more likely to participate in BAAC or AC credit programs (Menkhoff & Rungruxsirivorn, 2011). Menkhoff and Rungruxsirivorn (2011) compare households' reason behind borrowing credit from Thai Village Fund, the BAAC and, ACs in Thailand. The authors show that borrowing loans for farm production purposes from Thai Village Fund and ACs are not significantly different. In contrast, household who spend loans for consumption are less likely to borrow credit from the BAAC at the 5% level. Further, households borrowing for emergency and consumption smoothing, tend to borrow from informal sources because they require the money quickly (Menkhoff & Rungruxsirivorn, 2011; Zeller, 1994). Khoi et al. (2013) reveal that borrowers who access informal credit are more likely to borrow informal loans for consumption rather than other purposes.

Collateral is required by lenders in order to assess a borrower's creditworthiness (Zeller, 1994). Collateral or guarantor positively influences formal credit participation (Ololade & Olagunju, 2013; Menkhoff & Rungruxsirivorn, 2011). Menkhoff and Rungruxsirivorn (2011) and Fongthong and Suriya

(2014) find that rural Thai households with small size of land are less likely to borrow from formal lenders or BAAC. As a result, small landowners are more likely to receive credit from semi-formal or informal lenders. Similarly, Ololade and Olagunju (2013) show that having a guarantor positively influences farmers' access to credit in Nigeria at the 5% level, suggesting that households with guarantors have a 50.62% higher probability of credit access.

The effect of the interest rate on credit accessibility varies. Ololade and Olagunju (2013) show that an increase in interest rates decreases the probability of participation in the Nigerian credit market by 193%. On the other hand, the interest rate positively influence informal credit. Khoi et al. (2013) reveal that household demand for informal credit increases by 50% if an informal interest rate is raised by 1%. Since there are only few lenders, they can control the credit supply and interest rate. To obtain informal loans, borrowers have to accept loans with high interest rates. Moreover, informal loan size is determined by loan duration. The relationship between loan duration and informal loan amount is positive (Khoi et al., 2013). Informal credit contracts are flexible. The loan duration of informal loans depend on the borrower's repayment capacity. Households tend to borrow larger amounts of money when the loan duration is longer.

Geographic factors affect choices of credit sources and the loan amount. Geographic factors relate to physical environments, economic activities and infrastructures, which affect household borrowing (Khoi et al, 2013). Empirically, geographic factors are used to control for differences in location (Coleman, 1999; Pitt & Khandker, 1998). Regions, road access, and distance to markets are indicators used to measure credit providers' convenience. These factors have various effects on credit participation. Living in a village with easy road access means that individuals are more likely to access credit facilities (Khoi et al, 2013). Khoi et al. show that households which have access to a road have a 23.5% higher probability of microcredit participation at the 1% level. This implies that good transportation enables households to access credit providers fairly easily. In contrast, households living further away from the market are less likely to participate in credit programs (Duy et al., 2012). Duy et al. reveal that households' probability of credit access decreases as distance to nearest market increases.

Although determinants of credit access analysis from prior literature vary, key factors are household head, household characteristics, and geography factors. Age, gender, and education levels influence households' decisions to participate in credit programs. The results are mixed (see Table 3.1). For household characteristics, the number of household members, land/farm size, household income, and other loan access are important factors which affect credit participation. They have positive effects on access to formal credit and mixed effects on informal credit access. The last factor, geographical location, refers to the distance to the nearest market and location. Distance to town

negatively influences formal credit participation, while road accessibility positively affects formal credit participation since these indicators measure the convenience of access to lenders.

3.2.2 Marketing Service Participation

Small farmers are often confronted with limited access to farm input and output markets, due to high transaction costs (Alene et al., 2008; Barrett, 2008; Fischer & Qaim, 2012; Ortmann & King, 2007). Due to living in remote areas, poor infrastructure, and limited access to market information, farmers face with limited markets. They can overcome these barriers by accepting cooperative marketing services, including input (purchasing services) and output marketing. Agricultural cooperatives provide market information and marketing services for members, both in input and output. Obtaining market information can help farmers to reduce uncertainty over price and demand. Agricultural input marketing services help farmers access good quality inputs at lower prices, while output marketing services help them to obtain competitive prices for their farm products. These services contribute to greater bargaining power and price for the farmers (Chagwiza et al., 2016; Holloway, Nicholson, Delgado, Staal, & Ehui, 2000). Understanding what factors are important and who benefits from input and output marketing services is useful for policy development. It also encourages households to participate in non-credit support services and eventually improve household welfare.

The empirical literature on participation in AC marketing can be grouped into two groups; research which focuses on determinants on marketing participation and which considers the level of trade. The first group of the studies on AC marketing services explore the factors influencing a household's decision to participate in the AC market. Generally, empirical studies on market participation apply a binary choice model to estimate the probability of participating in marketing services since the dependent variable is defined as "to participate or not to participate". For example, Muthyalu (2013) applies a logit model to explore factors influencing cooperative members' participation in AC input and output marketing in Ethiopia. Using survey data from 163 AC members, the author concludes that household characteristics such as age, land ownership, and membership of ACs, market access, such as distance from AC, and information access influence household's marketing participation. Similarly, Chagwiza et al. (2016) explore the effects of participation in dairy marketing cooperatives in Ethiopia. They apply a logit model with the primary data categorized as cooperative and non-cooperative members. The findings of both studies show that land ownership and distance to ACs significantly influence households' decisions to participate in AC marketing.

Fischer and Qaim (2012) use a probit model to analyse the role of banana cooperatives in Kenya to promote smallholder farmers' participation in AC marketing services. Their model captures the transaction costs in relation to transportation and information cost. The ACs assist banana growers to

increase their market accessibility by reducing their transaction costs. Moreover, the authors take into account the endogeneity problem. To solve the endogeneity problem, the size of farm before joining the ACs is included in the model. Fischer and Qaim's (2012) findings have been replicated by Muthyalu (2013) and Chagwiza et al. (2016). Fischer and Qaim (2012) find that household endowment such as land ownership, productive assets, and credit access, significantly increase the probability of cooperative marketing participation. In addition, distance to the road and phone ownership, in relation to market information access influence households to join the AC. They conclude that the poorest of the poor banana growers and growers with less capacity to obtain information are more likely to be excluded from the AC marketing.

A number of studies have identified factors affecting the choices among different marketing channels (Ferto & Szabo, 2002; Zhang et al., 2017). Marketing channels include individual sales, selling via wholesalers, and selling via ACs. The multinomial logit model is used to explain which factors affect households' decisions to participate in a particular marketing channel. Ferto and Szabo (2002) analyse how transaction costs and household capital influence the choices of market channels for fruit and vegetable farmers in Hungary. In Ferto and Szabo's study, the marketing channels are divided into wholesale markets, wholesalers, cooperative marketing, and marketing provided by producer organizations. The sample is not random; they target traditional farmers. Their findings show that the probability of participating in cooperative marketing is positively influenced by age and phone ownership, whereas, it is negatively affected by assets and bargaining power. Similarly, Zhang et al. (2017) attempt to compare vegetable farmers' decisions to trade via different marketing channels in China using a multinomial logit model. The choice of vegetable marketing in their study is divided into vegetable markets, cooperatives, and wholesalers. Zhang et al.'s (2017) model includes household head characteristics, household production and sale characteristics. Their findings on the size of farmland and information access contrast with those of Ferto and Szabo (2002). That is agricultural land size positively affect AC marketing participation, while information accessibility about market price has a negative effect on participation in AC marketing.

Another group of empirical studies considers AC marketing participation as a two-step decision process. The first stage, called the selection process, is when households decide whether to use AC marketing services or not. In the second stage, called the outcome process, households who join AC marketing in the first stage decide how many input and output products are traded via the markets (Alene et al., 2008).

Determinants of the level of AC marketing participation can be estimated using the Tobit model or the Heckman model. However, this depends on the selection bias in the model. Mensah et al., (2012) investigate the determinants influencing the number of cashew nuts sold through AC

marketing. A two-limit Tobit model is applied since the proportion of sales via AC is a censored variable which falls into the range between 0 and 100 percent (Mensah et al., 2012). Some AC members do not sell farm products via AC marketing, whereas, some sell most of their farm products to AC. The study attempts to capture unobservable factors in the model. They add some psychosociological factors, such as household perceptions of AC marketing and performance. Their findings reveal that not only observed factors affect household marketing participation but also unobserved factors as well. The findings show that household perceptions of price benefit and satisfaction with AC management have a positive effect on the decision to participate in marketing cooperatives, but not significant on the amount of sale via ACs.

Other authors consider marketing participation as the two-stage processes with selection bias. Alene et al. (2008), Fischer and Qaim (2014), Ma (2016), and Winter-Nelson and Temu (2005) investigate factors affecting household participation in input and output marketing provided by ACs by taking account of the selection bias. The selection bias may take place in marketing participation because of non-random samples. The participating households have decided to participate themselves (Abebaw & Haile, 2013; Ma & Abdulai, 2016; Verhofstadt & Maertens, 2015). Households are heterogeneous (Ma & Abdulai, 2016). Although they have similar observable characteristics, they exhibit some different unobserved characteristics, such as farming ability and risk preferences. Such unobservable factors may significantly influence households' decision to participate in AC marketing services. Therefore, selection bias should not be ignored.

To control for the selection bias, the Heckman model is applied to analyse the factors of AC marketing participation. For example, Winter-Nelson and Temu (2005) and Alene et al. (2008) apply the Heckman selection model to estimate factors of market participation and level of trade. Winter-Nelson and Temu (2005) develop a model to explain the chemical fertilizer use of the Tanzanian coffee growers. Alene et al. (2008) follow Winter-Nelson and Temu's (2005) model to analyse the role of farmer group in farmers' participation in fertilizer and Maize markets in Kenya. Heckman selection model is implemented by both studies. In the first stage, the probability of participation in the market is estimated using the probit model. The inverse Mill's ratio (IMR) is generated in the first stage and applied in the second stage. In the second stage, the Tobit model is applied to estimate factors influencing the number of fertilizers purchased and farm outputs sold through AC marketing. The authors find that there is selection bias in input market participation. Therefore, input market participation analysis should take into account the selection bias to obtain unbiased results.

With a similar objective in mind, Fischer and Qaim (2014) apply the Heckman selection model to estimate factors affecting output market participation and the share of bananas sold through AC marketing channels. In the first stage, a logit model is applied to estimate the likelihood of

participation in the marketing channel. In the second stage, the Tobit and double-hurdle models are applied for the proportion of farm products sold via ACs. Fischer and Qaim (2014) use the Heckman-selection model to test the selection bias and find that the error term of the participation equation (equation of the first stage) and the quantity equation (equation of the second stage) are not related. Therefore, they conclude that the decision to participate in marketing and decision on the amount of output sold through AC marketing are separate decisions. The studies on this stream contribute to the literature on household market participation by developing the model beyond the decision to participate in the market. The model helps to explain household marketing participation; not only the decision to participate, but also the level of participation.

Most studies determine marketing participation factors by focusing only observable factors, such as individual characteristics, household and geographic factors. However, previous studies shows that unobserved characteristics are significant to AC marketing participation (Fischer & Qaim, 2014; Mensah et al., 2012). Previous studies capture unobserved factors by concentrating on household perceptions of risk and AC performance. In order to understand AC marketing, an investigation of factors affecting AC marketing participation should apply factors related to household perceptions of risk and AC performance.

Determinants of Marketing Service Participation

In the context of agricultural cooperatives, households' decisions to participate in marketing services does not depend solely on the costs and benefits received from the marketing service, but also household preferences and perceptions of ACs. The key determinants of marketing participation include households' risk and preferences, their production, and geographic factors. These are summarized in Table 3.2.

Household preferences include individual characteristics. Individual characteristics relate to marketing participation in two ways; individual risk preferences and the understanding the benefits obtained through AC marketing. Household risk preference is captured using age and education. The literature shows that only age is the primary factor affecting participation in AC marketing. The effects of age on AC marketing participation vary. Some studies have found that age has a positive effect on participation in AC output marketing (Chagwiza et al., 2016; Ferto & Szabo, 2002). Older farmers prefer less risk and tend to trust ACs rather than selling via wholesalers or wholesale markets. However, younger farmers prefer to sell their own products directly to the market in order to receive higher prices (Chagwiza et al., 2016; Ferto & Szabo, 2002). On the other hand, some studies have found that age has a negative effect on participation in AC marketing services (Alene et al., 2008; Muthyalu, 2013). The older farmers are not able to produce farm outputs that meet ACs'

standards, and since they are risk averse they are hesitant to adopt new technology (Alene et al., 2008; Muthyalu, 2013).

Household perceptions of the benefits of AC participation is one of the main factors influencing their decision to use marketing services (Fischer & Qaim, 2012, 2014; Mensah et al., 2012). Before making a decision to participate in AC marketing services, individuals will evaluate the benefits that they will receive from joining an AC. Mensah et al. (2012) measure benefits in terms of economic benefits, such as AC price, patronage refund preference, and trade credit preference. Fischer and Qaim (2014) suggest that benefits may be measured in term of access to other services, technology, and information provided by ACs. Mensah et al. (2012) and Fischer and Qaim (2014) show that only AC prices positively affect AC marketing participation. AC members compare prices offered by ACs to prices from alternatives. If ACs provide a higher price than others, they will sell their products via ACs (Mensah et al., 2012).

Mensah et al. (2012) measure AC performance based on AC effectiveness and satisfaction. They find that households with high levels of AC performance satisfaction are far more likely to participate in AC marketing service. Moreover, exploitation perception of intermediary traders is another factor identified as to whether households sell their produce via ACs (Fischer & Qaim, 2014). Exploitation perception implies farmers' trust of traders. If farmers feel that they are exploited by traders, they are more likely to sell their products through ACs.

Factors related to production and transaction costs are significant factors, which influence marketing participation since they directly relate to production and cost. These factors can be captured by land ownership, household assets, and production and sale characteristics (Ferto & Szabo, 2002; Fischer & Qaim, 2012). Land ownership affects household decisions to participate in marketing services since it indicates wealth and production capacity. The effects of land ownership on marketing participation vary. Mensah et al. (2012) and Zhang et al. (2017) show the relationship is positive. Zhang et al. (2017) find that farmers are more likely to use ACs as marketing channels increase to 40.9% when farm size increases by one unit. Fischer and Qaim (2012) provide more comprehensive results in the positive effect of farm or land size on market participation. The effects of land holding on joining marketing cooperatives is positive and is highest in the middle-class farmers. Fischer and Qaim (2012) show that an increase in land by one acre raises the farmer's probability of using ACs to sell bananas by about 47.3%. However, this trend decreases with farmers who have more than 11 acres. Fischer and Qaim's (2012) findings are in line with Bernard and Spielman's (2009). This means that the impact of squared land ownership on marketing participation is negative. Farmers with very small or large landholdings are less likely to join marketing cooperatives (Bernard & Spielman, 2009). Farmers with small holding do not have enough produce to sell via groups. However, farmers with

larger holdings may make higher profit when selling products to individual trade because it increases their bargaining power and transaction expenses are not high. In contrast, Chagwiza et al. (2016) and Wollni and Zeller (2007) argue that farm size has a negative impact on AC marketing participation. The most likely explanation for this is that larger farmers have a higher bargaining power to negotiate with private traders (Wollni & Zeller, 2007) and farmers with small landholdings benefit from ACs, rather than larger producers (Chagwiza et al., 2016).

Transaction costs can be divided into travel and information costs. Travel costs are measured by vehicle ownership and information costs are measured by phone, radio, or computer ownership. Vehicles imply access to the market (Alene et al., 2008). Communication assets such as phone, radio, and computer imply the access to information. Phones, radios, and computers are methods to access or exchange information, and allow communication among AC members and staff (Ferto & Szabo, 2002; Fischer & Qaim, 2012). Unlike other issues, there is agreement on the effects of vehicle and communication asset ownership on marketing participation. Having a vehicle or phone, radio, or mobile phone positively affect input and output marketing. Farmers with vehicle and communication assets are easily contactable and have more opportunities to join AC activities because of access to information (Alene et al., 2008; Ferto & Szabo, 2002; Fischer & Qaim, 2012, 2014).

Farmer decisions to join input and output marketing is directly related to production and sale characteristics. Input market participation has a positive correlation with factors related to household production such as irrigation accessibility (Ma & Abdulai, 2016). A study in China (Ma & Abdulai, 2016) shows that farmers who have access to irrigation are more likely to be AC members and use more fertilizers. As accessibility to irrigation ensures farmers have sufficient water for planting, they have a higher possibility of using inputs than farmers who do not have irrigation systems. For sale characteristics, product quality may impede farmer to sell via ACs (Ferto & Szabo, 2002; Zhang et al., 2017) because ACs require good quality farm products. In terms of sale amount, the sale volume depends on output price. Farmers compare prices offered by ACs with market price to decide the level of sales through ACs (Alene et al., 2008; Ouma et al., 2010).

Generally, geographical factors are captured using distance to the nearest market or road access. Distance to the nearest market or access to a road determines household participation in AC marketing (Fischer & Qaim, 2012). Households living near markets or roads can gain access to markets easily, thus they are more likely to sell their products by themselves rather than using AC marketing. In contrast households who live far from the markets or road are more likely to sell via ACs. For example, Fischer and Qaim (2012) find that farmers living far from the road have a higher probability of selling their products through ACs.

There are a few studies that investigate AC attributes that affect AC marketing participation. AC attributes in literature include late payments and distance to ACs. Fischer and Qaim (2014) find that delayed AC payments have negative effects on output marketing participation. The reason is that most farm households, particularly in developing countries, are poor and face liquidity constraints, so they prefer cash payment immediately. Similarly, distance to the AC center negatively influences AC marketing participation for both input and output markets because of high transaction costs.

3.2.3 Participation in Agricultural Extension Services

Agricultural extension services play a vital role in improving farm household production and eventually increase household welfare (Egziabher, Mathijs, Maertens, Deckers, & Bauer, 2011; Feder et al., 1985). Agricultural extension services directly influence household productivity. Agricultural extension services share farm knowledge in terms of technology and farm management with farmers (Feder et al., 1985). Individuals participating in agricultural extension services gain technology knowledge and improve management skills (Atsan, Isik, Yavuz, & Yurttas, 2009; Purcell & Anderson, 1997, as cited in Cerdan-Infantes, Maffioli, & Ubfal, 2008). They can adopt new technologies in their farming and manage their businesses efficiently. As a result, participating in agricultural extension services improves farmers' farm productivity leading to increase in output and profits (Atsan et al., 2009). Therefore, it is important to understand which factors influence households' decision to participate in agricultural extension services. Understanding of the determinants on extension service participation may help to develop better agricultural extension services.

Most of the empirical studies on agricultural extension services attempts to analyse what factors affect households' decisions to participate in agricultural extension services. Several models have been used to determine the determinants of household participation in agricultural extension services. First, Atsan et al. (2009) use the probit model to study Turkish farmers, while Egziabher et al. (2011) and, Elias, Nohmi, Yasunobu, and Ishida (2013) study Ethiopian households. They find that household decisions to participate in agricultural extension services are related to household head and household characteristics such as age of household head, education level, and household assets (Atsan et al., 2009; Egziabher et al., 2011; Elias et al., 2013). Moreover, Egziabher et al. (2011) and Elias et al. (2013) suggest that social capital, such as being members of some organization and working as a local government officer, increases the probability of households participating in agricultural extension services.

Table 3.2 Determinants of Marketing Service Participation

Dependent Variables	Output Marketing Service				Input Marketing Service			
	Selling Products via ACs		Number of Sales		Purchasing Input via ACs		Number of Input Use	
Independent Variables	Sign	Authors	Sign	Authors	Sign	Authors	Sign	Authors
<i>Household Head Characteristics</i>								
Age of HH Head	+/-	Chagwiza et al. (2016), Ferto & Szabo (2002), Alene et al. (2008),	+	Fischer & Qaim (2014)	-	Alene et al. (2008), Muthyalu (2013), Ma & Abdulai (2016)	+	Ma & Abdulai (2016)
Education of HH Head	+/-	Fischer & Qaim (2014), Chagwiza et al (2016), Zhang et al. (2017)	+	Fischer & Qaim (2014)	-	Ma & Abdulai (2016)		
Gender	+/-	Ouma et al. (2010), Alene et al. (2008)	+	Ouma et al. (2010)	-	Winter-Nelson & Temu (2005)	-	Winter-Nelson & Temu (2005), Alene et al. (2008)
Member of Another Group	+	Wollni & Zeller (2007)	+	Fischer & Qaim (2014), Alene et al. (2008)	+	Muthyalu (2013), Winter-Nelson & Temu (2005)	+	Alene et al. (2008)
<i>Household Characteristics</i>								
Family Size			+	Fischer & Qaim (2014)	-	Winter-Nelson & Temu (2005)	-	Winter-Nelson & Temu (2005)
Adult Member	+	Alene et al. (2008)	+	Alene et al. (2008), Ouma et al. (2010)				
Farm Equipment	+	Fischer & Qaim (2012)						
Livestock Ownership			+/-	Alene et al. (2008), Ouma et al. (2010)	-	Ma & Abdulai (2016)	+	Alene et al. (2008)
HH Owns a Car, Pick-up, or Motorbike	+	Fischer & Qaim (2014), Alene et al. (2008), Ouma et al. (2010)			+	Alene et al. (2008)		
HH Owns a Mobile Phone	+	Fischer & Qaim (2012), Chagwiza et al. (2016), Ferto & Szabo (2002)						
Non-farm Activity	+	Fischer & Qaim (2012)						
Off-farm Income	-	Alene et al. (2008)			+	Alene et al. (2008)	+	Alene et al. (2008)

Table 3.2 Determinants of Marketing Service Participation (cont.)

Independent Variables	Output Marketing Service		Input Marketing Service	
	Selling Products via ACs	Number of Sales	Purchasing Input via ACs	Number of Input Use
	Sign	Authors	Sign	Authors
Farm Income				+ Winter-Nelson & Temu (2005)
Other Crops	+	Fischer & Qaim (2014)	-	Fischer & Qaim (2014)
Land Owned	+/-	Fischer & Qaim (2012), Chagwiza et al. (2016), Alene et al. (2008)	+	Muthyalu (2013), - Alene et al. (2008)
Farm Size	+/-	Wollni & Zeller (2007), Mensah et al. (2012), Fischer & Qaim (2012, 2014) Zhang et al. (2017), Ouma et al. (2010)	+	Fischer & Qaim (2014) + Ma & Abdulai (2016)
Farm Size Squared	-	Fischer & Qaim (2012, 2014)		- Winter-Nelson & Temu (2005)
Access to Credit	+	Fischer & Qaim (2012), Alene et al. (2008)		
Access to Irrigation Facilities			+	Ma & Abdulai (2016)
Productivity	+	Fischer & Qaim (2014)	+	Fischer & Qaim (2014)
Low Quality Problem	-	Ferto & Szabo (2002)	+	Mensah et al. (2012)
Slow Sales	+	Zhang et al. (2017)		
Output Price			+	Alene et al. (2008), Ouma et al. (2010)
			+	Winter-Nelson & Temu (2005), Alene et al. (2008)
			+	Winter-Nelson & Temu (2005), Alene et al. (2008)
Household Preference or Attitude towards ACs				
Feel Exploited by Intermediary Traders	+	Fischer & Qaim (2014)		
Benefit (Price)	+	Mensah et al. (2012)	+	Mensah et al. (2012)
Satisfaction with AC Management	+	Mensah et al. (2012)		

Table 3.2 Determinants of Marketing Service Participation (cont.)

Independent Variables	Dependent Variables		Output Marketing Service		Input Marketing Service	
	Sign	Authors	Sign	Authors	Sign	Authors
AC Marketing Attributes						
Number of Shares in AC					+	Muthyalu (2013)
Late Payment	-	Fischer & Qaim (2014)	-	Fischer & Qaim (2014)		
Distance to ACs	-	Chagwiza et al. (2016),			-	Winter-Nelson & Temu (2005), Alene et al. (2008), Muthyalu (2013)
Geographical Factors (Information and Market Access)						
Distance from Farm to a Paved Road (km.)/the Nearest Market	+/-	Fischer & Qaim (2012), Zhang et al. (2017), Ouma et al. (2010)	-	Alene et al. (2008), Ouma et al. (2010)		+ Ma & Abdulai (2016)
Distance of Farm to Paved Road Square	-	Fischer & Qaim (2012)				
Access to Market Price	+/-	Ouma et al. (2010), Zhang et al. (2017)			-	Muthyalu (2013)
District	+/-	Ouma et al. (2010)	-	Mensah et al. (2012)		- Ma & Abdulai (2016)

Some studies focus on the role of ACs on agricultural extension participation. Agricultural cooperatives are considered important organizations to promote rural household production (Abebaw & Haile, 2013; Ma, 2016; Verhofstadt & Maertens, 2014). ACs encourage their members to participate in agricultural extension services such as the adoption of fertilizers and pesticide technology. In the context of AC, previous literature concentrates on the selection bias. Selection bias may take place since household decisions to participate in AC may be affected by observable and unobservable factors. Abebaw and Haile (2013) analyse the role of ACs on small farmers' agricultural technology adoption in Ethiopia. They use propensity score matching to control for observed characteristics. Their findings show that ACs are significant institutions that encourage small farmers to implement improved chemical fertilizers and pesticides. Fertilizer and pesticide adoption rates of AC members are significantly higher than non-AC members.

Similarly, Verhofstadt and Maertens (2014) and Ma (2016) find that the ACs have positive impacts on farmers' agricultural technology adoption in Rwanda and China, respectively. Verhofstadt and Maertens' (2014) study concludes that ACs play an important role in increasing pesticide technology for smallholder farmers in Rwanda. They use propensity score matching to control for observable characteristics and the willingness to pay as an additional control variable to control for unobserved bias. Their model proves the advantage of controlling for the selection bias, which occurs with observed and unobserved biases.

Besides the selection bias problem, Ma (2016) contends that AC participation may suffer from an endogeneity problem. The author examines the role of ACs in the implementation of organic fertilizer and pest management technology in China. To solve selection biases and endogeneity problems, Ma uses recursive binomial probit model and the endogenous switching probit model to estimate the probability of farmers' adopting fertilizers and pest management technology. His findings confirm that ACs facilitate greater use of improved organic fertilizers and pest technology adoption for improving smallholder farmers' productivity. This means that AC members are more profitable and are more likely to adopt technology than non-AC members.

With respect to participation in agricultural extension services, individual characteristics, household characteristics, and geographic factors play important roles. Most household factors have positive effects on participation in agricultural extension services, except for the age of the household head. Age refers to an ability to learn. Older farmers often do not want to change the way they farm and find it difficult adapting to new technologies. Thus, they are less likely to participate in agricultural extension programs (Atsan et al., 2009). Similarly, Egziabher et al. (2011) find that in Ethiopia, age increases the probability of participation in agricultural extension services until an individual reaches

44 years old. Household heads who are over 44 years old are less likely to participate in agricultural extension services.

Well-educated people have more opportunities to participate in agricultural extension services than uneducated people (Atsan et al., 2009; Tiwari, Sitaula, Nyborg, & Paudel, 2008). Education level relates to one's ability to access information and to understand new technologies. Participating in agricultural extension services enhances technology adoption leading to improved productivity. Therefore, people with higher education demonstrate a strong willingness to learn and apply knowledge from agricultural extension services, and they are more likely to join these services.

Being a member of a farmer group and working in a local government office positively influences agricultural extension service participation (Abebaw & Haile, 2013; Egziabher et al., 2011; Elias et al., 2013). Being a member of groups relates to social factors. The agricultural extension service provision in some countries, such as in Ethiopia and Thailand, often works cooperatively with development agencies and local governments. Therefore, people involved in farmer groups or local government have a higher possibility of accessing information about agricultural extension programs.

Regarding household factors relating to farm production, land ownership has a positive effect on agricultural extension service participation (Atsan et al., 2009; Elias et al., 2013; Tiwari et al., 2008). Land directly relates to new technology investment on farm and wealth. Households with larger plots of land can take greater risks, particularly in terms of adopting new technologies (Egziabher et al., 2011; Tiwari et al., 2008). Moreover, land size is correlated with wealth, influencing households' motivation to invest in farm technologies. Therefore, the larger the landholding size, the greater the probability of technology adoption and participation in agricultural extension services (Tiwari et al., 2008).

Location or geographical characteristics affect agricultural extension service participation since they indicate natural resources possessed by farmers, such as soil fertility and water supply (Ma & Abdulai, 2016). Households located in remote areas have limited farm resource accessibility, therefore, they are more likely to participate in agricultural extension services in order to use their resources more efficiently (Atsan et al., 2009).

3.3 Effects of Cooperatives on Household Welfare

An impact assessment is a process used to assess changes that are the result of a particular program. Impact evaluation contributes to program improvement (Hulme, 2000). ACs evaluate their services to identify which mechanisms can help the poor, and at what levels. Understanding ACs' constraints or problems helps ACs to design or extend their services in order to improve the effectiveness of their services and better help members.

The following section discusses impact evaluation method. The section reviews biases, which may occur in AC impact evaluations as well as various approaches to solve these biases. The impact of AC participation on households' welfare is also addressed.

3.3.1 Impact Evaluation Method

An impact assessment is generally measured in terms of an average impact (Gertler, Martinez, Premand, Rawlings, & Vermeersch, 2011). An average treatment effect is a comparison between the mean outcome if households receive treatment, a treatment group, and the mean outcome if the same households do not receive treatment, commonly referred to as a control group (Mojo et al., 2015b). The outcome in the absence of treatment is unobserved and is called a counterfactual outcome. To estimate an average treatment effect, an appropriate control group is required (Chagwiza et al., 2016; Mojo et al., 2015b). The challenge in assessing impact is defining non-participants in the control group whose outcomes are not bias. As a result of non-random self-selection in cooperative participation, there are three biases which may result in an AC impact evaluation (Chagwiza et al., 2016; Francesconi & Ruben, 2007).

A bias from observable characteristics may arise from the difference in observable characteristics between agricultural cooperative (AC) participants and non-participants. The observed characteristics influence the probability of joining ACs and the outcome of AC participation (Chagwiza et al., 2016; Francesconi & Ruben, 2007).

The self-selection bias on observable factors can be controlled using the matching method (Getnet & Anullo, 2012; Mojo et al., 2015b). The matching method will select the participants and non-participants who have similar observable covariates. Only participants and non-participants who have the similar observed characteristics influence program participation and outcomes are involved in a treatment effect estimation (Davis & Nkonya, 2008). In short, the matching method provides an unbiased treatment effect.

However, applying matched covariates leads to the problem of dimensionality. To overcome the dimensionality problem, Rosenbaum and Rubin (1983) suggest using a balanced score (Mojo et al.,

2015b). One of the balanced scores which is commonly applied to impact evaluation is Propensity Score Matching (PSM) because it can reduce the dimension of observable covariates and balance the observed characteristics between treatment and control groups (Mojo et al., 2015b). The PSM method matches participants and non-participants by using a propensity score (PS), a probability of participation in treatment. Only participants and non-participants with comparable PS are used to estimate treatment effects (Davis & Nkonya, 2008).

In the context of AC impact, PSM is used to estimate the average treatment effect on the treated (ATT) of AC membership on household economic welfare. As underlined in several studies, PSM is used to evaluate the AC impact on household income, farm production, market performance, or technology adoption in Ethiopia (Abebaw & Haile, 2013; Bernard, Taffesse, & Gabre-Madhin, 2008; Chagwiza et al., 2016; Francesconi & Ruben, 2007; Francesconi & Heerink, 2011; Getnet & Anullo, 2012; Mojo et al., 2015b). Ahmed and Mesfin (2017) apply PSM to assess the impact of AC participation on household consumption in Ethiopia. Ito et al. (2012) and Verhofstadt and Maertens (2014) apply PSM to estimate ATT of AC membership on farmer income and commercialization in China and Rwanda, respectively. They apply PSM to eliminate selection bias arising from observable characteristics. The ATT estimated by PSM is the mean difference of outcome variable on the AC participants and non-AC participants (Jena, Chichaibelu, Stellmacher, & Grote, 2012). The PSM method evaluates the effect of the treatment factor by controlling for all observed factors except the treatment variable. The PSM method requires cross-sectional data to compare outcomes between AC members and non-members.

Even though selection bias on observed characteristics are controlled by PSM, the individuals in treatment and control groups may differ in some unobservable characteristics. Unobserved characteristics, such as motivation, risk preference, and production skill, may influence their decision to participate in ACs and their outcome (Francesconi & Ruben, 2007; Verhofstadt & Maertens, 2014). As a result, the estimated AC impact is biased.

Based on the studies on AC impact, there are three ways to mitigate the selection-bias on unobservable characteristics. The first method involves using instrumental variables (IV) as an explanatory variable. While instrumental variable should relate to the households' decision to join the ACs, it should not affect the outcome of AC participation (Francesconi & Ruben, 2007). For example, Francesconi and Ruben (2007) use the military force member as an instrumental variable to control for the selection bias with respect to unobservable characteristics, since ACs in the study are established by retired military officers. Moreover, Ma (2016) uses a neighbour's membership as instrument variable. Military force membership and neighbour membership are used as IVs since they can explain the decision to participate in ACs, but they do not affect household income.

Secondly, a proxy variable is used to capture unobserved effects to mitigate the magnitude of unobservable bias. Sometime the instrumental variable estimation method cannot be applied because no good instrumental variable can be found. A proxy variable approach is appropriate to estimate the propensity score or the effects (Verhofstadt & Maertens, 2014). A proxy variable related to unobserved characteristics is included as an explanatory variable in models (Hoken, 2016; Hoken & Su, 2015; Ito et al., 2012; Verhofstadt & Maertens, 2014). Hoken (2016), Hoken and Su (2015), Ito et al. (2012), and Verhofstadt and Maertens (2014), all note, AC participation is influenced by unobservable characteristics such attitude toward agricultural production, attitude toward risk, willingness to adopt new technologies, and the impression of people in community on AC performance. These authors develop proxy variables to measure these unobserved factors and include them in their models.

The difference in differences (DID) method is suitable for controlling the unobservable bias since it can control time-invariant unobservable characteristic such as farmer skill, social network, and risk preferences (Heckman, Ichimura, & Todd, 1997; Hoken & Su, 2015; Smith & Todd, 2005). The DID method calculates the difference in the outcome variable before ($t=0$) and after ($t=1$) participation in ACs, for members compared with the difference in the outcome variable for non-members over the same time period (Hoken & Su, 2015). The DID method requires panel data for impact assessment.

Lastly, there is bias in the spill-over effect within the sample area (Francesconi & Ruben, 2007). ACs may have spill-over effects since large ACs may attract agricultural extension services and traders or industries (Francesconi & Ruben, 2007). These advantages may benefit non-AC members who live in the same area as ACs. Therefore, AC impact evaluated by a comparison between AC members and non-AC members in the same area is likely to be underestimated. To exclude a spill-over effect, Fischer and Qaim (2012) suggest that non-participants should be selected from areas without ACs. The authors evaluate farmer group impact in Kenya using PSM. PSM method assesses an income effect by comparing income between AC members and non-members. As a result of a comparison between AC participants and non-AC participants in the same area, the income effect is likely to be underestimated. They check the robustness for control group by using data from non-members located in areas that did not have ACs. Similarly, Francesconi and Heerink (2010) applies PSM to evaluate the impact of Ethiopian AC membership on commercialization. To mitigate a spill-over effect, the authors exclude non-participants who have relationships with AC members.

Our study evaluates the effects of AC service participation on household welfare using the Endogenous Switching Model (ESR). The ESR computes an average treatment effect on treated (ATT) and average treatment effect on the untreated (ATU) separately. ATT is the difference between the actual and counterfactual outcomes of AC service participants, while ATU is the comparison between

the counterfactual and actual outcomes of non-participants. Effects assessed by ESR method does not occur from comparing outcomes of AC participants with non-AC participant, thus the spill-over effect is not an issue in our study.

The effects of AC participation may be influenced by observed factors, such as farm production characteristics, and unobserved factors, such as farming skill, attitudes toward farm production, and attitudes toward risk and experience (Hoken, 2016; Hoken & Su, 2015; Ito et al., 2012; Dagne Mojo et al., 2015b). To mitigate both observable and unobservable selection biases, several methods have been applied. For example, Hoken (2016) and Ito et al. (2012) assess the impact of Farmers' Professional Cooperatives (FPCs) participation on farmers' income in China. The authors use the PSM method to control observable selection bias, and they also include farmers' attitudes on new technology adoption, risk preferences, and perceptions of ACs in their models.

Heckman et al. (1997), Smith and Todd (2005), and Takahashi, Higashikata, and Tsukada (2010) propose a combination of propensity score matching and difference in difference (PSM-DID) to mitigate observable and unobservable biases (Hoken & Su, 2015). As discussed above, the PSM method can mitigate selection bias of observable characteristics and DID can control the bias on unobservable ones. Therefore, applying a PSM-DID method can eliminate bias from both observable and unobservable characteristics. For example, Hoken and Su (2015) estimate the impact of the rice-producing cooperatives on Chinese rice farmers' income using the PSM-DID method. Applying the PSM-DID method requires the use of panel data. The PSM-DID method requires outcome data prior to and after becoming an AC member. Since most of the AC members in our study have participated in ACs for a long time, therefore, it is almost impossible to collect outcome data from the previous period. Due to the difficulty of obtaining panel data in our study, PSM-DID cannot be applied to evaluate the AC impact.

The Endogenous Switching Model (ESR) is another suitable approach for estimating the effects of AC participation on household welfare. This is because it can mitigate both selection biases on observable and unobservable factors. ESR is an alternative method which does not use panel data; it only requires cross-sectional data. Mojo et al. (2017) and Ma and Abdulai (2016) apply ESR to estimate the role of cooperative participation on apple growers' income and yields in Ethiopia and China, respectively. They use cross-sectional data surveyed in 2013 and employ the full information maximum likelihood (FIML) method to analyse determinants of AC participation and the impact of AC participation on household income and yield.

AC impact assessments are prone to three biases: observable, unobservable, and spill-over biases. These biases are the results of self-selection, incomplete information, assumptions of assessment

methods, and data availability (Smith, 2004, as cited in Khoi, 2012). To obtain consistent estimates, specific methods must be applied.

3.3.2 Effect of Cooperatives on Households Welfare

Poverty is multi-dimensional. Poverty can be measured via monetary or economic welfare and non-monetary or social dimensions (Sakonhawatt, Iswilanon, & Palarnuluk, 2012; United Nations Development Programme, 1997; World Bank, 2000). ACs play a role in reducing household poverty, both economic and social poverty.

Effect of Agricultural Cooperatives on Economic Welfare

ACs assist households to improve their economic welfare by enhancing access to credit and markets. Economic outcomes can be measured using either income or consumption approach. However, most studies on the effects of ACs have focused on income effects (Getnet & Anullo, 2012; Hoken, 2016; Hoken & Su, 2015; Ito et al., 2012; Verhofstadt & Maertens, 2014). However, the effect of ACs on rural household income is not straightforward. It depends on institutional innovations, location, socioeconomic status, as well as household characteristics (Hoken & Su, 2015; Verhofstadt & Maertens, 2014). The prevailing evidence which concentrates on different types of ACs in various countries exhibited positive, negative, and no effects on member incomes.

ACs enable members to earn more income rather than non-members through their diverse services. AC members exhibit higher farm income with agricultural extension services (Calkins & Ngo, 2010; Francesconi & Ruben, 2007; Getnet & Anullo, 2012). ACs improve members' productivity by providing improved materials, such as seed and fertilizers, agricultural techniques, and modern farm implements. The effect of agricultural extension services on income is documented in Calkins and Ngo (2010), Francesconi and Ruben (2007), and Getnet and Anullo (2012). Getnet and Anullo (2012) find that ACs extension services support farmers to use improved seeds. The members produce more and better yields, leading to more revenue. These findings are in line with Calkins and Ngo's (2010) study. Calkins and Ngo (2010) examine the role of cocoa cooperatives in Cote d'Ivoire and Ghana on rural households' production, marketing services, social development, and well-being. In Cote d'Ivoire and Ghana, cocoa cooperative members are encouraged to use modern farm implements and fertilizers. The members' yield per hectare is higher than non-members, by about 19%. Likewise, dairy cooperatives improve Ethiopian milk producers' productivity (by 5%) due to high-yielding cross-breed cows (Francesconi & Ruben, 2007).

Apart from agricultural extension services, ACs increase members' income via input and output marketing services. These activities increase small farmers' market access and provide links with other upstream and downstream enterprises in the supply chain. AC marketing services influence

input use and input costs, transaction costs, farm output prices, and output amounts through AC marketing services (Calkins and Ngo, 2010; Fischer & Qaim, 2012).

ACs impacts on input marketing service can be illustrated in two ways. Firstly, the AC input marketing service assists members with reducing average input costs. AC members purchase inputs at lower than market prices (Getnet & Anullo, 2012). Thus, they are able to reduce average input costs and increase their profits. Calkins and Ngo (2010) find that the average costs of fertilizers and pesticides for AC members growing coffee in Ghana are lower than non-AC members by USD7 and USD10, respectively. Because of the low input prices offered by ACs, AC members' profits are greater. Furthermore, due to low input prices, AC members may increase the number of input uses (Fischer & Qaim, 2012). For example, Fischer and Qaim (2012) find that banana growers in Ethiopia who are AC members apply more fertilizers and pesticides than non-AC members. Thus AC members' input expenses are greater than non-AC members.

Regarding AC output marketing services, ACs members selling farm output through AC marketing service improve their income in two ways; generating high prices and business opportunities (Getnet & Anullo, 2012; Ito et al., 2012; Verhofstadt & Maertens, 2015). Bernard et al. (2008) and Ito et al. (2012) compare the incomes of AC participants with non-participants in China. They find that AC member income is higher than non-AC members. The cause of increased income for AC members is higher product price provided by AC marketing (Fischer & Qaim, 2012; Wollni & Zeller, 2007). AC marketing services of coffee cooperatives in Costa Rica can increase the coffee price for members by USD 0.05 per kilogram (Wollni & Zeller, 2007). Fischer and Qaim (2012) find that AC members using AC marketing channels obtain greater income than selling individually because of higher prices. The authors find that the average banana price received from ACs in Kenya is higher than selling at the market by 23%.

Another advantage of using AC marketing is an improvement in market access. ACs form a bridge between farmers and purchasers. Moreover, ACs provide marketing facilities to encourage their members to sell through AC marketing. As a result, AC members can sell more products at higher prices than non-members (Calkins & Ngo, 2010; Chagwiza et al., 2016; Francesconi & Ruben, 2007). Chagwiza et al. (2016) find that the share of sales of dairy cooperative members is 0.36 times as much as non-members in Ethiopia. Francesconi and Ruben (2007) come to similar findings as Chagwiza et al. (2016). The sale amount of AC members is greater than those of non-members by approximately 20%. This is because ACs provide marketing facilities and technology innovations, such as transportation and food processing, to members. These facilities and innovation increase members' market accessibility and enable members to sell more products at a competitive price.

Some studies show that participation in ACs has a negative effect or no effect on members' income (Chagwiza et al., 2016; Hoken, 2016; Hoken & Su, 2015; Wollni & Zeller, 2007). The reasons that ACs cannot improve the AC members' income vary. The failure of AC marketing services can impede member income improvement (Bernard et al., 2008; Chagwiza et al., 2016; Francesconi & Heerink, 2011; Wollni & Zeller, 2007). Marketing failures may be due to cost competition. Chagwiza et al. (2016) show that dairy cooperatives in Ethiopia does not increase members' income since the cooperative cannot offer members competitive prices. Similarly, Fischer and Qaim (2012) and Wollni and Zeller (2007) find that ACs cannot provide higher price margins to their members because the increase in price is less than the increase in input costs in Kenya and Costa Rica, respectively. Bernard et al. (2008) and Francesconi and Heerink (2011) show that sale amount of AC members in Ethiopia do not differ from non-members due to the distrust of ACs. AC members worry about AC performance in Ethiopia (Bernard et al., 2008).

Another reason for no increase in income is unobservable factors such as cultivation skill and risk of farm production. Hoken and Su (2015), and Hoken (2016) find that ACs do not significantly improve farmers' incomes. They explain that the income difference between AC members and non-members is not a result of AC participation. Instead it is a result of cultivation skills, preferences for farm production, and social networks. If studies do not control for unobserved factors, the income of AC members will be significantly greater than those of non-members. However, the studies use PSM and DID to reduce bias from unobserved factors. The findings show that AC members and nonmembers' incomes are the same.

Studies on AC consumption impact is limited. AC participation increases household consumption (Ahmed & Mesfin, 2017; Wossen et al., 2017). Ahmed and Mesfin (2017) evaluate the impact of cooperative membership on the farm household consumption in Ethiopia. Consumption effect is measured by consumption per adult. The authors' findings show that ACs have a positive and significant impact on household consumption. Annual consumption for AC members is higher than non-members by 22.8%. Similarly, Wossen et al. (2017) investigate the impact of AC membership on rural household consumption in Nigeria. Household consumption is measured by food expenditure per capita. The findings show that AC membership has a significant and positive effect on food expense. AC membership raises household food expenditures by 12.5%.

The economic impacts in our study are measured in terms of income and consumption factors. Both income and consumption refer to household welfare. Income implies household earnings from farm production, off-farm activities, and money transfers, whereas, consumption refers to final goods and services consumed (O'donnell, Van Doorslaer, Wagstaff, & Lindelow, 2007). However, for developing countries, household income measurement is difficult. Since a large proportion of people work in

informal economic activities or are self-employed, they are hesitant to disclose their incomes (Grosh & Glewwe, 2000; O'donnell et al., 2007). Furthermore, household income in the agricultural sector fluctuates over farm seasons, while, household consumption is more stable (Haughton & Khandker, 2009). As a result, for developing countries, household consumption is more directly relevant to living standards rather than income. In order to obtain accurate living standard levels, our study applies household income and consumption indicators.

Effect of Agricultural Cooperatives on Social Welfare

Besides economic effects, ACs play an important role in promoting social welfare, particularly the education of members (Abebaw & Haile, 2013; Ma, 2016; Majee & Hoyt, 2010; Mojo, Fischer, & Degefa, 2015a). However, there are a limited studies on the effect of ACs on household education and health factors.

ACs play an important role in informal education improvement of members (Abebaw & Haile, 2013; Chagwiza et al., 2016; Fischer & Qaim, 2012). In general, the main ways to build up education are participating in formal and informal education (Mojo et al., 2015a). ACs play an important role in improving farmers' informal education. ACs improve members' informal education by providing agricultural extension services. AC members gain new knowledge and technologies through agricultural extension services. These services directly improve members' production skills.

The informal education effect of AC is usually measured by agricultural technology adoption. Abebaw and Haile (2013) confirm that cooperatives in Ethiopia exhibit a positive and statistically significant effect on fertilizer adoption. The fertilizer adoption rate for members is higher than non-members by about 9-10%. In the same way, Chagwiza et al. (2016) and Fischer and Qaim (2012) provide evidence that ACs significantly promote technological innovation. The dairy cooperatives in Ethiopia succeeded in supporting farmers to buy different breeds of cows. The authors' findings show that the proportion of members applying improved cow breed is higher than non-members by 22% (Chagwiza et al., 2016). Similarly, the mean of using banana tissue culture plantlet adoption for AC members is greater than non-member by 0.5 times (Fischer and Qaim, 2012). The similar results are found in China and Nigeria. Ma (2016) find that ACs increase the probability of pest management technology adoption by 30%. Wossen et al. (2017) show that Nigerian AC members are more likely to apply improved cassava varieties than non-AC members by 13%.

The research evaluating the impact of cooperatives on household health is limited. Prior literature measured the impact of AC participation on household health by using access to health care facilities (Calkins and Ngo, 2010) and household expenditure on health (Nghiem, Coelli, & Rao, 2007). Results of health impact vary due to different indicators. Calkins and Ngo's (2010) study shows that ACs in Cote d'Ivoire and Ghana do not improve members' well-being. The reason is that the AC members do

not have the potential to invest in facilities offered by ACs. The AC programs are introduced to the very poorest who live in remote areas with a lack of infrastructures. The AC members have to share costs to construct infrastructure, such as water towers, schools, and village clinics. Since the members are very poor, they cannot afford these investments through the ACs. As a result, the ACs cannot provide infrastructure to improve members' well-being. In contrast, Nghiem et al. (2007) find that credit participation improves household education and health status in Vietnam. The impacts of education and health in Nghiem's study are measured by expenditures on education and health. The author finds that ACs directly improve household income. The increased income encourages households to spend more on education and health care.

Previous studies show that ACs directly influence household income through the effects on farm performance such as input costs, input use, output price, sale, as well as productivity (Bernard et al., 2008; Chagwiza et al., 2016; Ma & Abdulai, 2016; Verhofstadt & Maertens, 2014, 2015; Wossen et al., 2017). Besides economic effects, ACs indirectly affect the education and health of households. However, empirical evidence on the relation between ACs and education and health effects are scarce. In terms of methodology, most of the studies employ PSM to control for the selection bias (Abebeaw & Haile, 2013; Ahmed & Mesfin, 2017; Bernard et al., 2008; Chagwiza et al., 2016; Francesconi & Ruben, 2007; Francesconi & Heerink, 2011; Getnet & Anullo, 2012; Ito et al., 2012; Mojo et al., 2015a, 2015b; Verhofstadt & Maertens, 2014). To bridge this gap, our study contributes to the literature by investigating the effects of AC credit and non-credit support services on household's economic and social welfare using the ESR method.

3.4 Chapter Summary

Credit and non-credit support services are important tools to assist farm households to improve their productions and incomes. Understanding the determinants of households' decision to participate in credit and non-credit support services helps practitioners improve household participation in these services. The demand theory explains factors influencing households' demand including demand for credit and non-credit support services. Regarding credit, household demand is determined by interest rates, farm endowments, and household characteristics. However, the rural credit market in Thailand tends to have credit rationing due to asymmetric information. Credit rationing and signalling theory are able to explain loan amount granted. Asymmetric information influences lenders' decisions to approve loans. When credit demand exceeds supply, lenders rationing credit and impose various conditions in the contracts to distinguish types of borrowers such as different interest rates, loan size, collateral requirements, and loan maturities. Empirical studies show that credit participation involves negotiation between borrowers and credit providers; therefore, it covers both demand and supply factors. Household participation in the credit market is determined by

individual and household characteristics (e.g. age, education, land ownership, and productive assets), credit attributes (e.g. credit purpose, collateral, and loan duration), and geographic factors such as distance to the nearest market and region dummy.

In terms of non-credit support services (i.e. marketing services), demand theory and transaction cost concept provide the explanation for household participation in marketing services. Household participation in markets are determined by household characteristics affecting their production, fixed transaction costs, and proportion transaction costs. The empirical literature on participation in AC marketing services confirms that the key determinants of marketing participation include individual and household characteristics (e.g. age, education, land size, and household members, irrigation access, product quality, agricultural risks), household perception of AC performance and benefits (e.g. AC effectiveness, AC satisfaction, access to technologies, and market information accessibility), and geographic factors; distance to nearest market and region dummy. Furthermore, level of marketing participation is influenced not only factors of household features (household characteristics, household perception of AC performance, and geographical factors) but also marketing attributes (i.e. distance to ACs, and late payment for output marketing).

Empirical studies demonstrate that ACs play a considerable role in poverty reduction for rural households. Most studies on the effects of ACs have focused on household income through the effects on farm performance such as input costs, input use, output price, sale, as well as productivity. The empirical evidence indicates that ACs enable members to earn more income through their diverse services such as credit, marketing, and agricultural extension services. However, some studies show that participation in ACs has a negative effect or no effect on members' income. Reason for various effects of ACs on household welfare is unobservable factors such as cultivation skill and risk of farm production. The presence of unobserved factors influencing households' AC participation and their outcome leads to the selection bias. Effects of ACs are subject to the assumption of unobserved factors and impact evaluation method. Difference in the assumption of unobservable factors results in different methods for impact evaluation. In Thailand, the research on an assessment of AC effects on household welfare are limited. It is necessary to evaluate the effect of ACs to develop better AC services and to improve household welfare.

Chapter 4

Research Methodology

This chapter describes the empirical models applied in our study. This chapter is organized as follows. Section 4.1 provides an overview of model specifications and estimation strategies used to examine the determinants of participation in AC and their services; credit and non-credit support services. The methods used to evaluate the effects of AC service participation on rural Thai households' welfare are presented in Section 4.2. This section includes outcome indicators, the empirical model, and information about the impact estimator approach. Data collection is discussed in Section 4.3 which covers the questionnaire design and sampling techniques. Profiles of sampled households in the survey are discussed in Section 4.4.

4.1 Determinants of Participation in Agricultural Cooperative

4.1.1 Model Specification

In our study, participation in AC services is defined as the decision to participate in AC services. It examines the level of participation; for instance, the loan amount, the level of input use, and the quantity of farm products sold. The method used to analyse households' decisions to be AC membership and participate in AC services is the probit model. The Heckman selection model is applied to analyse levels of participation in AC services; credit and marketing services.

Choice of Participation in Agricultural Cooperatives

Since AC service participation in Thailand does not allow for non-member, the decision to participate in AC services has two steps. Firstly, Households decide whether or not to participate in ACs. When they are AC members, they can choose to use credit and non-credit support services. Therefore, AC participation analysis in our study includes households' decision to be AC members and participate in AC services.

As discussed in section 3.2, the relationship between households' decisions to participate in AC and determinants influencing AC participation are captured by the choice theory. A binary choice model is applied to analyse the decision to be AC membership and participate in AC services since the dependent variable is a binary outcome (participation or non-participation). The probit and logit models are used to estimate the probability of participation. Both models are different in assumptions about the distribution of the error term. For the probit model, the error term is assumed to be normally distributed, while in the logit model, the error term is logistically distributed. Both models provide consistent, efficient, and asymptotically normal estimated parameters (Li, Gan,

& Hu, 2011a). In addition, the prediction results of both models are similar. However, the probit model is better suited for examining the factors behind AC participation because it can be used for smaller samples (Tetteh Anang et al., 2015; Wollni & Zeller, 2007).

According to Abebaw and Haile (2013), Fischer and Qaim (2012), Mojo et al., (2015b), and Wollni and Zeller (2007), a household's decision to participate in AC is based on the idea of utility maximization. The actual utility level of each household is unobservable, however, the utility function can be expressed as a function of a vector of exogenous variables (\tilde{Z}_{ij}). The utility function consists of two parts; a vector of explanatory variables (\tilde{Z}_{ij}) and the error term (ε_{ij}) (Dubin & Rivers, 1989). The explanatory variables are observable factors which influence utility. The error term captures the unobservable factors affecting the utility, but are not included in the explanatory variables. The utility function can be expressed as:

$$\mu_{ij} = \delta Z_{ij} + \varepsilon_{ij} \quad (j = 0,1) \quad (4.1)$$

Where μ_{ij} is the utility level of household i choosing the alternative j; j is the choice/decision (participation in AC =1 and = 0 otherwise); \tilde{Z}_{ij} is the vector of explanatory variables; δ is the unknown parameter; and ε_{ij} is the error term.

To capture AC participation, our study assumes that households are risk neutral and consider the potential net returns (Ma & Abdulai, 2016). The household decides to participate in AC, if the expected net return obtained from participating in AC (μ_{ij}) is higher than not participating (μ_{i0}). D_i^* is defined as the difference between the expected net returns from participating in AC and not participating.

$$D_i^* = U_{i1} - U_{i0} \quad (4.2)$$

D_i^* is unobserved but is presented as a latent variable model. Substituting equation (4.1) into equation (4.2) and defining $Z_i = Z_{i1} - Z_{i0}$ and $\varepsilon_i = \varepsilon_{i1} - \varepsilon_{i0}$, yields

$$\begin{aligned} D_i^* &= (\delta Z_{i1} + \varepsilon_{i1}) - (\delta Z_{i0} + \varepsilon_{i0}) = \delta (Z_{i1} - Z_{i0}) + (\varepsilon_{i1} - \varepsilon_{i0}) \\ D_i^* &= \delta Z_i + \varepsilon_i \end{aligned} \quad (4.3)$$

Households participate in AC, if D_i^* is larger than zero. It means that the expected net returns obtained from participating in AC are greater than not participating. Otherwise, households would choose not to participate in ACs.

The relationship between D_i and D_i^* can be expressed as follows:

$$D_i = \begin{cases} = 1, & \text{if } D_i^* > 0 \\ = 0, & \text{if otherwise} \end{cases} \quad (4.4)$$

Our study carries out two estimations for AC participation: AC membership and participation in AC services. Firstly, the estimation explores determinants of AC membership. Thus, D_i is a binary outcome which equals 1 when household i decides to be AC membership and 0 otherwise. Secondly, the study investigates the determinants of AC members' decision to participate in AC services. Hence, the dependent variable equals 1 for participants in AC service and 0 for non-participants. Z_i is a set of explanatory variables. γ is a vector of parameters and ε_i is an error term. The error term is assumed to be normally distributed with zero mean.

The probability of participating in AC can be expressed as follows:

$$\begin{aligned} \Pr(D_i = 1 | z_i) &= \Pr(D_i^* > 0 | z_i) = \Pr(\delta z_i + \varepsilon_i > 0) \\ &= \Pr(-\varepsilon_i < \delta z_i) = F(\delta z_i) \end{aligned} \quad (4.5)$$

Where F is the cumulative distribution function for ε_i . This model assumes that ε_{i1} and ε_{i0} have a joint normal distribution with a mean of zero. The cumulative distribution function for ε_i is

$$F(\varepsilon) = \Phi\left(\frac{\varepsilon}{\sigma}\right) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\varepsilon} e^{-t^2/2} dt \text{ and } \sigma^2 = \text{Var}(\varepsilon_{i1} + \varepsilon_{i0}).$$

To associate AC participation with expected net returns, we assume households are rational and seek net return maximization from farm production. The expected net returns can be shown as follows:

$$\pi = P_o Q(R, Z) - P_i I \quad (4.6)$$

Where P_o is a vector of farm product prices and Q is a vector of total farm yields. P_i is a vector of input prices and I is a vector of inputs such as seeds, fertilizers, pesticides, and labour. Z is a vector of the explanatory variable. Q is a production function which $\partial Q / \partial I > 0$ and $\partial^2 Q / \partial I^2 < 0$ (Ma & Abdulai,

2016). Net returns can be presented as a function of input and output prices, the choice of participation in AC and AC services (D), and observable characteristics is given as:

$$\pi = f(P_o, P_i, D, Z) \quad (4.7)$$

The first order condition of the net return function (equation 4.6) provides a reduced form for output supply function:

$$Q = f(P_o, P_i, D, Z) \quad (4.8)$$

The model can be modified to capture households' decision to participate in AC marketing services. As Key et al. (2000) argue, households' decision to participate in AC marketing services depends on the transaction costs and benefits of participation. Transaction costs are divided into fixed and proportional costs. Proportional transaction costs raise farmers' input prices $(P_i + TC_i^P)$ and reduce farmers' real output prices $(P_o - TC_o^P)$ (Key et al., 2000; Ouma et al., 2010). Fixed transaction costs for input and output markets influence farmers' decisions to participate in marketing services and reduce their net returns. The expected net return is presented as:

$$\pi = \left[(P_o - TC_o^P)Q - (P_i + TC_i^P)I - TC_o^F - TC_i^F \right] \quad (4.9)$$

Where π denotes a household's expected net returns; P_o and P_i are market prices for output and input, respectively. TC_o^P and TC_i^P denote the proportion transactional costs per unit of output and input, respectively; TC_o^F and TC_i^F are the fixed transaction costs for output and input markets, respectively. Q is the number of farm yields and I is the number of inputs.

Based on equation (4.9), a reduced form of net returns function is identified by input and output prices, proportional transaction costs for input and output markets, and household and farm characteristics (Z) (Ma, 2016). It can be represented by equation (4.10)

$$\pi = f(P_o, P_i, TC_o^P, TC_i^P, Z) \quad (4.10)$$

Based on the net return function (equations 4.7 and 4.10), households' expected net return is defined by input and output prices, the choice of participation in AC services, and observable factors. Prior empirical studies have shown that the participation in AC and AC services and expected net returns are determined by individual characteristics, household factors, and geographical factors (Bernard et al., 2008; Fischer & Qaim, 2012, 2014; Francesconi & Heerink, 2011; Ma & Abdulai, 2016; Mojo et al., 2017). However, some empirical evidence shows that farm risks and farmers' attitudes in

AC performances directly influence households' decisions to participate in ACs (Fischer & Qaim, 2014; Hoken, 2016; Ito et al., 2012; Mensah et al., 2012; Zheng, Wang, & Song, 2011). This allows us to have more control over the unobservable factors in the choice of AC participation. Including these variables means that the empirical model of our study is different from other empirical studies of AC participation. AC participation variables are adapted from previous studies. The variables are categorized into four groups; individual characteristics, household factors, household perception toward farm risk and AC performance, and geographic factors.

Heckman Selection Model

When analysing factors related to level of AC service participation, one needs to take into account selection bias. In section 3.2.2, we discussed that participation in AC services may lead to selection bias; this is because households choose to participate in ACs (Ma & Abdulai, 2016). Both observable and unobservable factors influence households to participate in AC services. Therefore, the sample is not random. In addition, the decision to participate in AC services is a sequential process (Abebaw & Haile, 2013; Alene et al., 2008; Duy et al., 2012; Fischer & Qaim, 2014; Girma & Abebaw, 2015; Khoi, 2012; Mensah et al., 2012; Tetteh Anang et al., 2015). Firstly, households decide whether to participate in AC services or not. Secondly, only participating households choose the level of services they require, such as the loan amount, the sale quantity, and the input amount traded through ACs. The latter process is more likely to lead to a bias because only data from AC participants is considered. Data from non-participants is excluded from the sample.

To address the selection bias, determinants related to the participation level is analysed using the Heckman selection model. The Heckman model is one of the most commonly applied approaches because it is able to mitigate the selection bias (Duy et al., 2012). For example, Tetteh Anang et al. (2015), Khoi (2012), Duy et al. (2012), and Girma and Abebaw (2015) apply the Heckman model to investigate factors which encourage households to access credit. Similarly, Alene et al. (2008), Fischer and Qaim (2014), and Winter-Nelson and Temu (2005) apply the Heckman model to identify the factors of household participation in input and output marketing services, the input amount and sales traded.

The Heckman selection model consists of two steps; the participation or selection process and the outcome process. In the first step, households choose to participate in AC services. As discussed above, this stage is analysed using the probit model. In the second step, households participating in AC services choose their levels of participation. Samples in this step only include those households who decide to use AC services. Therefore, the outcome equation in the second step is estimated using information from households who are AC service users. The sample selection is expressed in the following equations

$$y_i = \beta x_i + \mu_i, \text{ Given } D_i \text{ equals one} \quad (4.11)$$

$$D_i^* = \delta z_i + \varepsilon_i \quad (4.12)$$

Where y_i denotes participation level in AC services; x_i denotes the vector of explanatory variables influencing participation levels in AC services; β denotes the parameters; and μ denotes the error term. The Heckman selection model relies on the assumptions below (Wooldridge, 2010):

1. D_i and z_i are observable. Participation levels (y_i) are only observed when households participate in AC services ($D_i = 1$). This assumption concentrates on the sample selection problem. When a household's expected net return of AC service participation exceeds non-participation ($D_i^* > 0$), it will participate in AC services ($D_i = 1$). Then participation levels in AC services (y_i) are observable. In contrast, if D_i^* is negative, a household decides not to participate in AC services and y_i is unobserved.
2. The error terms (ε, μ) are normally distributed with zero means and are independent of the set of explanatory variables. Their variances are σ_ε^2 and σ_μ^2 and covariance ($Cov(\varepsilon, \mu)$) is σ . This assumption refers to the exogeneity of z_i .
3. The error term of the selection equation is normally distributed with zero means ($\varepsilon \sim Normal(0,1)$). The assumption that the variance of ε equals 1 ($\sigma_\varepsilon^2 = 1$) does not lead to a loss of generality because D_i is a binary variable.
4. If both error terms are correlated, then the expected value of μ is conditional on the sample selection which is non-zero, denoted by $E(\mu|\varepsilon) = \gamma\varepsilon$

Since the level of AC service participation (y_i) is observable only when a household participates in AC services ($D_i = 1$), the expected level of AC service participation can be expressed as:

$$E(y_i | D_i = 1) = E(y_i | z_i, \varepsilon) = E(\beta x_i) + E(\mu | z_i, \varepsilon) \quad (4.13)$$

Since $E(\beta) = \beta$ and $E(x_i) = x_i$, we must rewrite equation 4.13 to obtain

$$E(y_i|z_i, \varepsilon) = \beta x_i + E(\mu|z_i, \varepsilon) \quad (4.14)$$

According to the assumption that μ is an independent set of explanatory variables and

$E(\mu|\varepsilon) = \gamma\varepsilon$, equation (4.14) can be rewritten as:

$$E(y_i|z_i, \varepsilon) = \beta x_i + \gamma\varepsilon \quad (4.15)$$

If γ equals zero, this indicates that the error terms of participation and outcome equations are not related, and that the model does not have a sample selection problem. Then β is consistently estimated by OLS using the selected sample. However, if γ does not equal zero, equation (4.15) can be rewritten as:

$$E(y_i|D_i = 1) = \beta x_i + \gamma E(\varepsilon|D_i = 1) \quad (4.16)$$

Households will participate in AC services if the difference between the expected net return from participation is higher than not participating ($D_i^* > 0$). Substituting equation (4.12) when D_i^* is more than zero into equation (4.16), we get:

$$E(y_i|D_i = 1) = \beta x_i + \gamma E(\varepsilon|\varepsilon > -\delta z_i) \quad (4.17)$$

The value of $E(\varepsilon|\varepsilon > -\delta z_i)$ in equation (4.17) presents the omitted variables arising from the selected sample. Let $E(\varepsilon|\varepsilon > -\delta z_i)$ is $\lambda(\delta z_i)$. Where $\lambda_i(\delta z_i) = \frac{\phi(\delta z_i)}{\Phi(\delta z_i)}$; ϕ and Φ are the standard normal density function and standard normal cumulative distribution function, respectively. $\lambda(\delta z_i)$ is IMR. Therefore, equation (4.17) can be rewritten as:

$$E(y_i|D_i = 1) = \beta x_i + \gamma \lambda(\delta z_i) \quad (4.18)$$

IMR ($\lambda(\delta z_i)$) captures the unobservable variables in the selected sample (Wooldridge, 2010). β and γ can be obtained by regressing y_i on x_i and $\lambda(\delta z_i)$. Although δ is unknown, the estimate of δ can be derived from the probit estimation of the participation equation (equation 4.5). The Heckman two-step method can solve the selection bias and provide unbiased and consistent estimators based on IMR.

Our study focuses on participation level of three AC services: credit, input, and output marketing services. Thus, there are three Heckman selection models in our study. The Heckman selection model for each AC service consists of participation equation (equation 4.12) and participation level equation (equation 4.11). The dependent variable (y_i) in the participation level equation for AC credit is loan amounts. While the dependent variable for AC input marketing service is input expenses through ACs and for output marketing service is farm product quantity sold to ACs.

The explanatory variables are drawn from existing literature on determinants of loan amount and input and output levels traded through marketing services. These factors can be broadly grouped into individual, household, and geographic characteristics. These factors reflect loan applicants' characteristics such as human capital, financial capital endowments, transaction costs, and farm production ability. In addition to attributes of the demand side, the participation level of AC services is directly determined by AC service attributes.

In section 3.1.2, we discussed the credit rationing theory that explained why some borrowers are limited to access credit. Loan amount is determined by both the demand and supply factors (Zeller, 1994). First, the choice of participation in a credit program is influenced by factors affecting household demand for credit, such as individual and household socioeconomic factors. Next, lenders decide whether to fully or partially grant the requested amount. To associate credit rationing and the demand for credit, our study uses the AC credit model and includes credit program attributes. In this study, credit attributes/variables included are chosen from previous literature (Khoi, 2012; Menkhoff & Rungruxsirivorn, 2011; Ololade & Olagunju, 2013) and include AC share value, type of collateral, and loan duration.

The AC marketing participation model in our study includes marketing channel attributes. Marketing channel attributes determine household participation levels in AC marketing service since they affect households' net farm returns (Winter-Nelson & Temu, 2005). For example, output prices offered by ACs positively influence the quantity of farm products sold through it, while the price obtained by alternative channels have negative effects on participation in AC marketing services (Mensah et al., 2012; Wollni & Zeller, 2007). Access to AC marketing services, measured by distance to ACs, is expected to negatively influence participation levels for AC marketing services (Winter-Nelson & Temu, 2005; Wollni & Zeller, 2007). The further the distance is, the greater transportation costs are likely to be. This leads to lower household net returns. The explanatory variables for AC marketing attributes included in the AC marketing services participation model are drawn from prior empirical studies (Fischer & Qaim, 2014; Mensah et al., 2012; Muthyalu, 2013; Winter-Nelson & Temu, 2005). AC marketing attributes in our study are AC share value, input payment method, output prices offered by AC, other output market channel, and distance from residence to AC center.

The model has two main advantages in terms of analysing households' decision to participate in AC services. First, the model overcomes the selection bias problem. The model takes into account the fact that households choose to participate in ACs. Selection bias might occur since Thai ACs have criteria to screen whether to accept individual applicants. For example, applicants have to be farmers living in areas covered by specific ACs. Their farms also have to be a certain size to generate enough income to repay their loans. Moreover, the model acknowledges that a household's decision to participate in AC services is a two-step process. This is particularly true in terms of credit and marketing service participation. Analysing the decision to participate, separate from the level of participation, might lead to the endogeneity of unobservable factors. Second, the model attempts to provide a better explanation for participation levels in both AC credit and marketing services. Thus, the model captures AC attributes.

4.1.2 Estimation Strategy

The main variable in this study is the participation level. It is determined by a vector of explanatory variables and the error term (μ_i). The error term (μ_i) is assumed to be normally distributed. The participation level in AC services is observed when households participate in AC services ($D_i = 1$). Since only the choice of participation in AC services is observable, participation in AC services is illustrated as a latent equation (equation 4.18-1). The system equation of AC service participation, known as the Heckman selection model, is given as:

$$D_i^* = \delta z_i + \varepsilon_i \quad (4.18-1)$$

$$D_i = \begin{cases} = 1, & \text{if } D_i^* > 0 \\ = 0, & \text{if otherwise} \end{cases}$$

$$y_i = \beta x_i + \mu_i \quad \text{Given } D_i = 1, \quad (4.18-2)$$

This system of equations can be estimated using the Heckman two-stage approach (Khoi, 2012; Tetteh Anang et al., 2015). The steps are:

Step 1. Estimate the probit model to determine the probability of participation in AC services using all observations. This process provides the vectors of consistent coefficient δ . Then calculate IMR ($\lambda_i \equiv \lambda(\hat{\delta}Z_i)$) of the probit model.

Step 2. Add IMR, an explanatory variable, into the outcome equation (equation 4.18-2) and run y_i on x_i, λ_i to obtain the coefficients β and the coefficient of IMR (γ). These estimators are consistent and asymptotically normal.

The Heckman two-stage method is able to correct selection bias because of IMR. IMR captures omitted unobservable variables (Tetteh Anang et al., 2015). Selection bias can be determined using a standard t-test on γ . The null hypothesis means that there is no selection bias, $H_0 : \gamma = 0$. If H_0 holds, it means that the error term in participation and outcome equation are not correlated. Therefore, there is no selection bias.

Under the null hypothesis, $\text{Var}(y|z, D_i = 1) = \text{Var}(y|z) = \text{Var}(\mu)$, homoskedasticity holds

(Wooldridge, 2010). Moreover, when $\gamma = 0$, the asymptotic variance of γ and β is not influenced by δ . In contrast, when $\gamma \neq 0$, $\text{Var}(y|z, D_i = 1)$ is not constant. This means there is heteroskedasticity problem. However, heteroskedasticity can be corrected by applying robust standard errors.

To avoid collinearity among the regressors in an outcome equation regression, explanatory variables for the outcome equation (X_i) can overlap explanatory variables for the participation equation (Z_i). However, at least one variable (a selection instrument variable), affects a household's decision to participate in AC services but does not affect their level of participation (Ma, 2016; Mojo et al., 2017; Wossen et al., 2017). To address collinearity among the regressors, our study uses household's expected benefits from AC services as a selection instrument variable in the Heckman selection model since it affects a household's decision to participate in AC services, but does not affect their level of participation.

4.1.3 Addressing Potential Endogeneity

To obtain consistent estimates, it is important to address endogeneity problems in the participation equation. Some explanatory variables may be potentially endogenous explanatory variables (EEVs) in AC member participation and AC credit participation (Khoi et al., 2013; Ma & Abdulai, 2016). Regarding AC membership, access to credit and agricultural extension services may be jointly determined by AC membership (Ma & Abdulai, 2016). A household's decision to participate in ACs is determined by the demand for credit and agricultural extension services. In contrast, ACs assist households to obtain credit and agricultural extension services (Abebaw & Haile, 2013; Wossen et al., 2017). Therefore, credit access and agricultural extension service access might be endogenous variables in the AC participation equation.

In terms of participation in credit services, other complementary or substitute loans are also considered. Households may borrow additional money from other credit programs (Duong & Izumida, 2002; Fongthong & Suriya, 2014; Khoi et al., 2013). Loan size, or the money granted by

other lenders, is an endogenous variable since it is determined by household characteristics (Khoi, 2012). Our study, thus, includes endogeneity of other loans in AC credit participation.

If there are endogenous variables in the participation equation, applying the standard probit method will provide biased and yield inconsistent estimates (Wooldridge, 2010). Endogenous variables should be treated before using the Heckman selection model. Various estimation methods have been used to estimate the probit model with endogenous variables (Rivers & Vuong, 1988). Heckman (1978) proposes a two-stage least squares method (2SLS). The 2SLS estimator can be applied by using standard probit and regression. The 2SLS method provides only approximate and no appropriate distribution results for the estimators (Miranda & Rabe-Hesketh, 2006). Amemiya (1978) proposes a generalized two-stage simultaneous probit model (G2SP) to improve the efficiency of the Heckman estimator. This method estimates the parameter estimates of structural equations from parameter estimates of reduced equations. Rivers and Vuong (1988) suggest a two-stage conditional maximum likelihood model (2SCML). 2SCML is easier for computation and more efficient than the Heckman and Amemiya estimators (Rivers & Vuong, 1988). Therefore, our study employs Rivers and Vuong's (1988) approach to estimate the probit model with endogenous variables.

Rivers and Vuong's (1988) model consists of a structural equation and a reduced form equation. The structural equation is the primary interest equation, which is the participation equation in our study. A household's decision to participate in AC and AC services depends on the explanatory variables, including exogenous variables (Z_i) and endogenous variables (G_i) (see equation 4.19). A reduced form equation for the EEVs is a function of all the other explanatory variables (Z_i) in the participation equation and a set of instruments (S_i). The set of equations are presented below:

$$D_i^* = \delta z_i + \eta G_i + \varepsilon_i, \text{ if } D_i^* > 0, D=1 \text{ and } 0, \text{ otherwise} \quad (4.19)$$

$$G_i = \delta Z_i + \omega S_i + \xi_i \quad (4.20)$$

Where G_i is a vector of observed endogenous variables; Z_i is a vector of explanatory variables affecting the decision to participate in AC and AC services; S_i is a vector of instrument variables. δ, ω are the parameters; and ξ_i is an error terms.

Rivers and Vuong's (1988) model requires at least one explanatory variable as an instrumental variable. An instrument variable significantly affects endogenous variables but does not influence the choice of participation (Khoi et al., 2013; Ma & Abdulai, 2016). Thus, instrument variables must be excluded from the participation equation estimation (equation 4.19). Moreover, it is not correlated with the selection instrument variable used in the Heckman selection model. To address these issues,

our study uses “a member of other associations” as an instrumental variable for EEVs in the participation equation of AC membership and AC credit models. Being a member of other associations is expected to significantly identify EEVs (access credit and agricultural extension services) but does not influence the decision to participate in AC membership and AC credit.

Rivers and Vuong’s (1988) approach has two steps. Step 1. Regress G_i on Z_i and S_i to get δ, ω . Next, compute the least squares residuals (R_i) and add the residuals as an explanatory variable in the participation equation (equation 4.20). The participation equation can be rewritten as follows:

$$D_i^* = Z_i\delta + G_i\eta + R_i\kappa + \varepsilon_i \quad (4.21)$$

Where R_i is a vector of residual terms estimated from equation (4.20). Adding the residuals transforms the endogenous variables into appropriate exogenous variables since the residuals perform control functions (Wooldridge, 2010).

Step 2. Run the probit of D_i^* on Z_i, G_i , and R_i to find the vectors of consistent coefficients (δ, η, κ) This approach provides a test for the endogeneity of the endogenous variables by using the t-test for the coefficient κ . If κ equals zero, it means ξ_i and ε_i are not related. Therefore, an endogeneity problem does not exist and G_i is an exogenous variable (Wooldridge, 2010).

4.2 Effect Evaluation of Agricultural Cooperative at the Household Level

ACs aim to mitigate farmers’ poverty. ACs are designed to support members’ businesses and improve their welfare. Participation in AC services provides opportunities for households to improve their income and consumption levels, and increase household members’ education, and improve their health. This section discusses the outcome indicators used to measure AC effects on household welfare. The empirical model for impact evaluation of AC services is presented in the next section.

4.2.1 Outcome Indicators of Effect Evaluation

The poor cannot escape from poverty because they often confront multiple issues, including a lack of financial capital, high rates of illiteracy, low skills, and bad health due to poor and a lack of access to health services (Birchall & Simmons, 2009). Insufficient income is the main cause of all of these issues. Lack of capital impedes people from expanding their businesses and farm productions. Due to lack of financial capital, the poor must often borrow money. They cannot borrow from formal lenders since they do not have assets which they can use as collateral. If they choose to borrow from informal lenders, they may become trapped by high interest rates and become poorer as a result or permanently indebted. One way to help people escape from this trap is to provide loans with low

interest rates so that they can balance their income and interest payments (Birchall & Simmons, 2009).

Low income people are often unable to increase their education and remain stuck in low-skilled jobs due to their illiteracy. The poor cannot afford to send their children to school; instead, children are often required to work to contribute to the family income. Moreover, the poor are often trapped by their bad health. Under-nourished individuals cannot work productively, which means that they are unlikely to earn a high income (Birchall & Simmons, 2009).

ACs provide a way to escape from poverty or at least raise a household's income level (Birchall & Simmons, 2009). The various ways that ACs can help households reduce poverty are illustrated in Figure 4.1. ACs credit and marketing services directly improve household's income, while, AC agricultural extension services develop household's farm production skill. ACs provide loans to farmers with lower interest rates compared to other money lenders. Because of ACs' loan provision, rural households are able to reduce reliance on traditional/informal loans (Siamwalla et al., 1990). Households can use these loans to support their production. However, providing loans to uneducated or unskilled members is a risk. Thus, ACs encourage members to participate in agricultural extension services to gain knowledge and improve their production skills. AC agricultural extension services provide farm knowledge, information about how to improve inputs and use modern technology. These services improve farmer productivity. ACs help members combat market failure. ACs also help members to purchase inputs and sell outputs. ACs can offer a lower price for inputs and a higher price for outputs to its members than private traders. Moreover, members can purchase inputs from ACs on credit. AC marketing services increase members' profits. Eventually, credit and non-credit support services facilitated by increasing household income. With increased income, households can spend more on food and other goods.

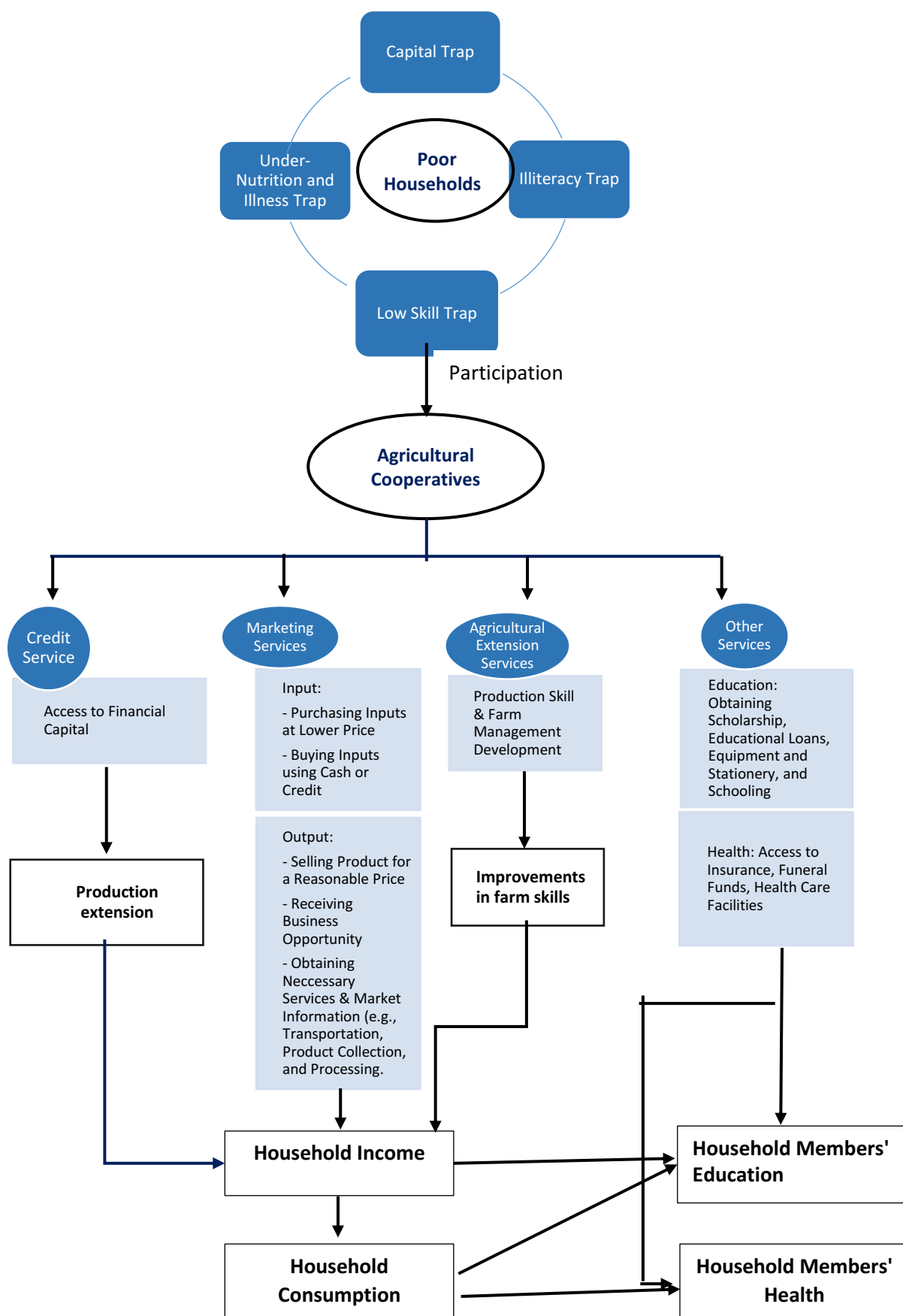


Figure 4.1 Effect of Agricultural Cooperative Participation
Source: Developed for this study

In addition to increased income, ACs contribute to household members' education and health. Some ACs are directly involved in educational activities, such as building schools, providing scholarships or educational loans, equipment and stationery (Birchall & Simmons, 2009). These activities increase children's educational opportunities and help to break the poverty cycle. Children are not the only ones to benefit from these educational opportunities; adults are also able to participate in educational programs. ACs improve members' farm skills and technology knowledge through training. In terms of health, some ACs offer low-cost insurance, funeral funds, and health care facilities for members, like those in Tanzania, Sri Lanka, and Thailand. In Thailand, some ACs improve members' education and health by contributing to their members' education and health expenses (Thuvachote, 2011).

According to Figure 4.1, AC credit participation directly impacts household income, consumption, farm skill improvement, children's education access, and health access. For non-credit support services, AC marketing services directly influence household income and consumption and eventually influence children's education access and health access. While AC agricultural extension services directly affect farm skill improvement. Therefore, to satisfy the objectives of our study in parts of the effects of AC services, our study will evaluate the effects of three AC services. Firstly, the study will investigate the effects of AC credit participation including household income, consumption, farm skill improvement, children's education access, and health access. Next, the study will evaluate the effects of participation in AC marketing and agricultural extension services as the representation for non-credit support service. The effects of AC marketing service participation involve household income, consumption, children's education access, and health access, while, the effect of participation in AC agricultural extension services include only farm skill improvement.

Regarding indicators for AC effects, our study considers economic and social indicators related to the effects of AC participation on household welfare; income, consumption, education, and health (see Figure 4.1). These indicators were chosen from prior literature. Table 4.1 provides a summary of the economic and social effect indicators found in the literature. The economic indicators include total household income, household farm income, gross farm revenue, and household consumption including food and non-food expenses. Our study applies total household income and household farm income to capture the income effect. Total household income includes annual farm, off-farm, and transfer payments in Thai Baht. The effect on household consumption is measured using household expenditure on food and other goods.

Table 4.1 Economic and Social Indicators

Effects		Indicators	Authors
Economics	Income	Total Income	Mojo et al. (2015b, 2017), Getnet & Anullo (2012), Jena et al. (2012)
		Income per Capita	Jena et al. (2012), Ma (2016), Hoken (2016), Calkins & Ngo (2010)
		Farm Income	Chagwiza et al. (2016), Hoken & SU (2015), Hoken (2016), Zheng et al. (2011), Getnet & Anullo (2012)
		Farm Revenue	Verhofstadt & Maertens (2014, 2015)
		Farm Income per Farm Worker	Hoken (2016), Verhofstadt & Maertens (2014)
		Farm Income per Ha	Ma (2016), Hoken & SU (2015), Hoken (2016)
		Farm Income per Day	Ito et al. (2012)
		The ratio of Farm Income to HH Income	Chagwiza et al. (2016), Calkins & Ngo (2010)
	Consumption	Per Capita Consumption Expense	Jena et al. (2012), Ahmed & Mesfin (2017)
		Per Capita Food Expense	Wossen et al. (2017)
	Yield	Total yield	Mojo et al. (2015b)
		Yield/day	Chagwiza et al. (2016), Ito et al. (2012)
	Productivity	Yield/Ha.	Chagwiza et al (2016), Verhofstadt & Maertens (2015), Ma (2016), Calkins & Ngo (2010), Fischer & Qaim (2012), Francesconi & Ruben (2007)
			Verhofstadt & Maertens (2014), Fischer & Qaim (2012,2014), Francesconi & Ruben (2007), Francesconi & Heerink (2011)
Market Performance	Sale	Share of Sale	Bernard et al. (2008), Fischer & Qaim (2014)
		Sale Amount	Chagwiza et al. (2016), Fischer & Qaim (2012), Wollni & Zeller (2007)
	Price	Price/Kg.	Ito et al. (2012), Calkins & Ngo (2010), Fischer & Qaim (2012)
		Price Margin (Profit/Kg.)	Verhofstadt & Maertens (2014), Ma (2016), Getnet & Anullo (2012)
	Input expense	Total Input Expenses (Fertilizers, Pesticides, seeds)	Calkins & Ngo (2010), Fischer & Qaim (2012), Ma (2016)
		Input Expenses per Ha	
Social	Informal Education	Adoption of Technologies or Improved Inputs	Wossen et al. (2017), Verhofstadt & Maertens (2014), Calkins & Ngo (2010), Getnet & Anullo (2012), Abebaw & Hail (2013)
		Expense on Schooling	Sinha & Rasmussen (2007), Holvoet (2004), Omoro (2013), Duvendack (2011), Doan et al. (2014)
		Education expense per school-age child	Doan et al. (2014)
	Formal education	Enrolment Rate	DFID (1999), Duvendack (2011), Pronyk (2007), Sinha & Rasmussen (2007), World bank (2000), Ghana Statistical Service (2013)
		Health Access	Omoro (2013), Pronyk (2007)
		Health Expenses	Duvendack (2011)
	Health	Ability to Affordable Health Care Services	Grameen bank (2017)

In our study, the social indicators consist of education and health effects, which are measured using numerical and self-evaluated variables. Households were asked to compare changes in their household welfare (focusing on education and health) over a three year period (2014-2016). The self-evaluated education and health indicators were measured using a three-point rating scale, ranging from 1=no change, 2= moderate improvement, 3= extreme improvement.

Education effect consists of effects on formal education (children's education) and informal education (adults' farm knowledge and technology adoption). Children's education is measured using enrolment and expenditure on schooling. Primary and middle education is compulsory for all Thai children. Children can access to compulsory education in two ways, attending school and non-formal education. Attending non-formal education is an alternative way for poor households to support their children access to education. Poor households do not have enough income to send their kids to school, in addition, they need children to work in order to obtain more income. Non-formal education is suitable for poor children since it is part-time study and tuition fee is low. The effect on children education in our study focuses on formal education. School enrolment is used to measure children education effect. School enrolment reflects households' abilities to provide their children the basic education. A school enrolment variable in our study is a dichotomous variable which equals 1 when every school-aged child (6-15 years old) in family attends school and 0 otherwise.

Besides, the effect on children's education is measured by schooling expense. There is a difference between sending children to private and public schools (Holvoet, 2004). Private schools have high tuition fees and often have higher miscellaneous costs. It is cheaper to send children to public schools than private schools, or that parents who send their children to private schools are wealthier. To capture the difference between private and public school, schooling expense is used to calculate the effect of education. Following the UNESCO Institute for Statistics (UIS), schooling expenditures in our study include direct expenses (tuition fee and other fee charged for educational services) and indirect expenses (expenses for food, uniform, stationery, and transportation) (Oseni et al., 2018).

In this study, informal education is measured using a self-evaluation method. Households were also asked whether they apply new technology, modern farm materials, and improved farm knowledge (farm production and management) to their farm production. The variable measuring adoption of improved farm technologies and practices is a dichotomous variable which equals 1 when households apply improved farm technologies and practices in their productions and 0 otherwise.

The effect of ACs on household health is measured using access to health care facilities and the ability to afford health care services. Access to health care facilities is measured using household perceptions of improvement in access to health care; this is a self-evaluated variable. An improvement in health access is a dichotomous variable which equals 1 if households' health access

is better off and 0 otherwise. Moreover, our study also includes the ability to afford health care services, following the Grameen bank's indicator for poverty assessment (Grameen Bank, 2017). Affordability is an important concept because if households spend a lot of money on a particular item, such as food or education, they then have to reduce their consumption of other goods and services (Niens et al., 2012). This concept is applied to measure the affordability of health care. If households have more income they are able to seek health care when they need it. As a result, household healthcare is more affordable. Our study defines health affordability in terms of what household income remains after paying for food and education.

4.2.2 Empirical Model Specification

An average treatment effect on the treated (ATT) is used to evaluate the effects of a particular program. The treatment effect is the difference between the actual and the counterfactual outcome. When individuals participate in treatment, they have two outcomes; actual and unobserved outcomes. The unobserved outcome refers to the outcome that would have occurred when the individuals do not participate in the treatment. As the counterfactual outcome cannot be observed, treatment effect estimation must be done using an average treatment effect, instead of an individual treatment effect (Steiner & Cook, 2013, as cited in Mojo et al., 2017).

ATT is usually used to evaluate the effects of AC memberships. ATT measures the average difference in participant and non-participant outcomes. However, ATT estimation may be subject to selection biases (Mojo et al, 2017). As noted above, farmers choose to participate in ACs (Ahmed & Mesfin, 2017; Ma & Abdulai, 2016). The choice of AC participation is influenced by both observable characteristics, such as age, gender, and education levels, and time-invariant unobservable characteristics, such as households skills, social networks, risks, and leisure preferences (Hoken & Su, 2015; Ma & Abdulai, 2016). Applying ordinary least square (OLS) to estimate the treatment effect with selection biases will yield inconsistent and biased estimates (Ma & Abdulai, 2016)

The standard approaches for dealing with the selection bias can be divided into different categories based on the types of dependent variables. PSM and ESR models are commonly used for models with a continuous dependent variable. RBP and ESP models are used with binary dependent variables. The PSM method is applied to estimate the treatment effects of AC participation to control for selection biases; however, it can only mitigate the observable selection bias. To control for selection biases from both observed and unobserved factors, our study applies the ESR model to assess the effects of AC service participation. In terms of the binary dependent variables, the ESP has advantages over the RPB model (Lokshin and Sajaia, 2004; Ma, 2016). Firstly, ESP model, using the FIML technique, provides consistent standard errors of the estimates; it thus yields consistent estimates. In contrast, RBP requires potential adjustments for deriving consistent standard errors (Lokshin and Sajaia, 2004).

Secondly, the ESP approach estimates the determinants of outcome variables separately, for both AC and non-AC participants. Although the RBP model can control for both observed and unobserved selection biases, it can only estimate the selection equation with one outcome equation (Ma, 2016). Therefore, the RBP model cannot separate determinants of AC participant outcomes and those of non-participants. Enhancing household welfare through AC services requires understanding of the factors that influence AC and non-AC participants' decisions separately.

In our study, outcome variables are continuous (such as household and farm income, household consumption, educational expenses, health affordability) and binary (such as school enrolment, adoption of improved farm technologies and practices, and improvement of health accessibility). Therefore our study estimates the effects of AC service participation using the ESR model for continuous outcome variables and the ESP models for binary outcome variables. Both of these models apply the FIML method to estimate participation and outcome equations simultaneously (Lokshin & Sajaia, 2004; Ma & Abdulai, 2016; Mojo et al., 2017; Shiferaw, Kassie, Jaleta, & Yirga, 2014).

Endogenous Switching Regression Model

The ESR model applied in our study is based on Lokshin and Sajaia (2004), Ma and Abdulai (2016) and Mojo et al.'s (2017) work. The ESR model has two stages, the selection and the outcome stage. In the first stage, a selection or participation equation is a binary model (see equation 4.12). The selection equation is used to determine the probability of household participation in AC services using all observations; AC service participants and non-AC service participants. In the second stage, the outcome functions are specified by two regime equations; regime 1 for AC service participants and regime 2 for non-participants. Outcome functions are illustrated below:

$$\text{Regime 1:} \quad y_{iP} = \beta_{iP}x_i + \mu_{iP} \quad \text{if } D_i = 1 \quad (4.22a)$$

$$\text{Regime 2:} \quad y_{iN} = \beta_{iN}x_i + \mu_{iN} \quad \text{if } D_i = 0 \quad (4.22b)$$

Where y_{iP} and y_{iN} are the outcomes of interest (which are continuous variables), such as household income, farm income, household consumption, education expenses, and health affordability, for AC service participants and non-participants, respectively; x_i denotes a vector of explanatory variables influencing the outcome; β is a vector of the parameters estimated; and μ_i is a random disturbance term.

The ESR model assumes that the error terms in the selection and outcome equations ($\varepsilon, \mu_{iP}, \mu_{iN}$) are a normal distribution with zero mean and their variances are σ_ε^2 , σ_P^2 and σ_N^2 , respectively.

The covariance term between the error term in the selection and the outcome equation of participants in AC services ($Cov(\varepsilon_i, \mu_{iP})$) are $\sigma_{\varepsilon P}$ and the covariance for non-participants ($Cov(\varepsilon_i, \mu_{iN})$) are $\sigma_{\varepsilon N}$. If the error term in the selection equation is related to the error term in outcome equations, the expected values of μ_{iP} and μ_{iN} conditional on the sample selection are non-zero (Di Falco, Veronesi, & Yesuf, 2011).

$$E(\mu_{iP} | D_i = 1) = \sigma_{\varepsilon P} \frac{\phi(Z_i)}{\Phi(Z_i)} = \sigma_{\varepsilon P} \lambda_{Pi} \quad (4.23a)$$

$$E(\mu_{iN} | D_i = 0) = -\sigma_{\varepsilon N} \frac{\phi(Z_i)}{1 - \Phi(Z_i)} = \sigma_{\varepsilon N} \lambda_{Ni} \quad (4.23b)$$

Where $\phi(\cdot)$ and $\Phi(\cdot)$ are the standard normal probability density function and the standard normal cumulative density function respectively; λ_{Pi} and λ_{Ni} are IMR calculated from using the selection equation. Where $\lambda_{Pi} = \phi(Z_i)/\Phi(Z_i)$ and $\lambda_{Ni} = \phi(Z_i)/(1 - \Phi(Z_i))$. If the estimated $\sigma_{\varepsilon P}$ and $\sigma_{\varepsilon N}$ are statistically significant, it means that a household's decision to participate in AC services are correlated with outcomes. Hence, there is the presence of endogenous switching or selection bias (Mojo et al., 2017).

The ESR model addresses both observable and unobservable selection biases. A vector of explanatory variables (x_i) in the outcome equation (equations 4.22a and 4.22b) capture observed characteristics which influence a household to participate in AC services. Unobserved factors are captured by an error term. If there is an endogenous switching or a selection bias ($corr(\varepsilon_i, \mu_i) \neq 0$), the ESR model is able to mitigate these problems by adding IMR (λ_{iP} and λ_{iN}) and the covariance terms ($\sigma_{\varepsilon P}$ and $\sigma_{\varepsilon N}$) estimated using the selection equation, as additional explanatory variables in the outcome equation:

$$y_{iP} = \beta_{iP} x_i + \sigma_{\varepsilon P} \lambda_{iP} + v_{iP} \quad \text{if } D_i = 1 \quad (4.24a)$$

$$y_{iN} = \beta_{iN} x_i + \sigma_{\varepsilon N} \lambda_{iN} + v_{iN} \quad \text{if } D_i = 0 \quad (4.24b)$$

Where IMR (λ_{iP} and λ_{iN}) capture the selection bias, which occurs from unobserved characteristics; v_{iP} and v_{iN} are the error terms that have a normal distribution with zero means (Mojo et al., 2017).

The selection and outcome equations are estimated simultaneously using the FIML method (Lokshin

& Sajaia, 2004). The FIML method provides consistent standard errors; therefore, the estimates are efficient.

A vector of explanatory variables in the selection and outcome equations are allowed to overlap. However, the ESR model requires that at least one explanatory variable in a vector of explanatory variables in the selection equation is excluded from the outcome equation (Ma & Abdulai, 2016; Mojo et al, 2017; Shiferaw et al., 2014). The excluded variable is called a selection instrument variable. This requirement safeguards the ESR model from linearity problems. The valid selection instrument variable has to influence households' decisions to participate in AC services but not influence outcomes (Ma & Abdulai, 2016). Following Ma and Abdulai (2016) and Mojo et al. (2017), our study employs two variables; the neighbour's AC membership and distance to the nearest market or town as the selection instrument variable. Neighbour and relatives, who are AC membership, indicate social network. Social network is likely to have a positive influence on AC participation. However, it does not affect household incomes (Ito et al., 2012; Ma & Abdulai, 2016). Similarly, households living closer to town tend to have easier access to credit, input and output markets, and agricultural extension services, since the agents who provide those services are located in town (Mojo et al., 2017). Therefore, distance to town may affect household participation in AC services. Our study expects to find that both selection variables do not directly influence outcomes.

When the ESR model is estimated, it yields the coefficients of correlation ($\rho_{\varepsilon P}$ and $\rho_{\varepsilon N}$). $\rho_{\varepsilon P}$ is the coefficients of correlation between ε_i and μ_{iP} and $\rho_{\varepsilon N}$ is the coefficients of correlation between ε_i and μ_{iN} . Where $\rho_{\varepsilon P}$ equals $(\sigma_{\varepsilon P} / \sigma_{\varepsilon} \sigma_P)$ and $\rho_{\varepsilon N}$ equals $(\sigma_{\varepsilon N} / \sigma_{\varepsilon} \sigma_N)$. If $\rho_{\varepsilon P}$ or $\rho_{\varepsilon N}$ equals zero, it means that there is no selection bias. Therefore, consistent estimators can be obtained using OLS. While, $\rho_{\varepsilon P}$ or $\rho_{\varepsilon N}$ is statistically significant, indicating there is a selection bias from unobservable factors (Ma, 2016; Miranda & Rabe-Hesketh, 2006). The treatment effect estimation must take into account observable and unobservable factors.

The signs of $\rho_{\varepsilon P}$ and $\rho_{\varepsilon N}$ have economic interpretations (Alene et al., 2008; Ma, 2016). When $\rho_{\varepsilon P}$ and $\rho_{\varepsilon N}$ are statistically significant with a different sign, it means that households participate in AC services on the basis of their comparative advantage. Households participating in AC services have above-average interested outcomes (e.g., income, consumption, and education status) from using AC services and those who do not participate in AC services have above-average interested outcomes from not using AC services. In contrast, if the signs of correlation coefficient are same, this means that AC service participants have above-average outcomes whether they use AC services or not, but

they are better off participating. While non-AC service participants have below-average outcomes in either choice but they are better off not participating. A positive $\rho_{\varepsilon P}$ refers to a negative selection bias, indicating that households whose outcomes are below the average outcome are more likely to participate in AC services. In contrast, a negative $\rho_{\varepsilon P}$ implies positive selection bias.

Endogenous Switching Probit Model

Our study applies the ESP model to estimate the effects of AC service participation on school enrolment, the adoption of improved farm technologies and practices, and health access improvements. These effects are binary in nature. The ESP model consists of two stages (Lokshin & Sajaia, 2011; Ma, 2016). Firstly, households decide to participate in AC services, as illustrated by equation (4.12). The outcome equations for AC service participants and non-participants are specified in equations (4.25a) and (4.25b.) The probit model is applied together with the participation equation to examine the probability of AC service participation and the outcome equations to investigate the relationship between an outcome variable and explanatory variables, conditional on the choice of AC service participation (Ma, 2016). The outcome equations are given as follow:

$$y_{li}^* = \beta_1 x_{li} + \mu_{li} \text{ with } y_{li} = \begin{cases} 1 & \text{if } y_{li}^* > 0 \\ 0 & \text{if } y_{li}^* \leq 0 \end{cases} \text{ if } D_i = 1 \quad (4.25a)$$

$$y_{0i}^* = \beta_0 x_{0i} + \mu_{0i} \text{ with } y_{0i} = \begin{cases} 1 & \text{if } y_{0i}^* > 0 \\ 0 & \text{if } y_{0i}^* \leq 0 \end{cases} \text{ if } D_i = 0 \quad (4.25b)$$

Where y_{li}^* and y_{0i}^* are the latent variables determining the observed binary outcomes y_{li} for AC participants and y_{0i} for non-participants. y_{li} and y_{0i} equals one if AC service participants and non-participants send every school-aged child to school (for school enrolment outcome), and zero otherwise. The other outcomes, the adoption of farm technologies and practices and the improvement of household health access, are defined in the same way. x_i is the vector of explanatory variables influencing an outcome variable; β is the vector of parameters; and μ_i is a random disturbance term.

The ESP model assumes that the error terms, in the participation and outcome equations are jointly normally distributed with a mean-zero vector. The correlation matrix can be expressed as follows:

$$\Omega = \begin{bmatrix} 1 & \rho_0 & \rho_1 \\ & 1 & \rho_{10} \\ & & 1 \end{bmatrix} \quad (4.26)$$

Where ρ_1 denotes the correlation between μ_{1i} and ε ; ρ_0 denotes the correlation between μ_{0i} and ε ; ρ_{10} denotes the correlation between μ_{1i} and μ_{0i} . Since y_{1i} and y_{0i} cannot be observed simultaneously, the joint distribution of (μ_{1i}, μ_{0i}) is not identified. Thus, ρ_{10} cannot be estimated. This study assumes that ρ_{10} equals one (Lokshin & Sajaia, 2011).

The system of equations (equations 4.12, 4.25a, and 4.25b) is estimated simultaneously using the FIML method. The FIML method yields consistent standard errors for estimates (Lokshin & Sajaia, 2011). In the ESP estimations, ρ_1 and ρ_0 are automatically generated and included in the outcome equations for both participants (equation 4.25a) and non-participants (equation 4.25b). This mitigates the selection bias arising from unobserved factors (Ma, 2016).

4.2.3 Estimation Strategy

Average Treatment Effects for Endogenous Switching Regression Model

The ESR model allows us to obtain actual and counterfactual expected outcomes (Mojo et al., 2017). The actual expected outcomes for AC service participants and for non-participants are illustrated in equations (4.25a) and (4.25b), respectively. The counterfactual expected outcomes for AC service participants and non-participants are illustrated in equations (4.25c) and (4.25d), respectively.

$$E(y_{iP} | D_i = 1) = \beta_{iP}x_i + \sigma_{\varepsilon P}\lambda_{iP} \quad (4.25a)$$

$$E(y_{iN} | D_i = 0) = \beta_{iN}x_i + \sigma_{\varepsilon N}\lambda_{iN} \quad (4.25b)$$

$$E(y_{iN} | D_i = 1) = \beta_{iN}x_i + \sigma_{\varepsilon N}\lambda_{iP} \quad (4.25c)$$

$$E(y_{iP} | D_i = 0) = \beta_{iP}x_i + \sigma_{\varepsilon P}\lambda_{iN} \quad (4.25d)$$

An ATT is the difference between the actual and counterfactual outcomes of AC service participants (the difference between equations 4.25a and 4.25c) are outlined below (Di Falco et al., 2011; Ma, 2016):

$$\begin{aligned} ATT &= E(y_{iP} | D_i = 1) - E(y_{iN} | D_i = 1) \\ &= (\beta_{iP} - \beta_{iN})x_i + (\sigma_{\varepsilon P} - \sigma_{\varepsilon N})\lambda_{iP} \end{aligned} \quad (4.26)$$

An average treatment effect on the untreated (ATU) is the difference between the counterfactual and actual outcomes of non-participants (the difference between equations 4.25d and 4.25b is shown below).

$$\begin{aligned}
ATU &= E(y_{iP} | D_i = 0) - E(y_{iN} | D_i = 0) \\
&= (\beta_{iP} - \beta_{iN})x_i + (\sigma_{\varepsilon P} - \sigma_{\varepsilon N})\lambda_{iN}
\end{aligned} \tag{4.27}$$

Average Treatment Effects for Endogenous Switching Probit Model

The ESP model estimates can determine ATT and ATU. ATT is the mean of the treatment effect on the households who participate in AC services (TT) (Lokshin & Sajaia, 2004). For example, the average effect of AC credit on farm technology adoption on treated (ATT) can be calculated by averaging TT over the AC credit participants. TT is the difference between the probability of farm technology adoption (choice of outcome) for AC credit participant i (actual probability) and the probability of farm technology adoption for AC credit participant i if the participant did not borrow money from ACs (counterfactual probability). ATT can be express as follows (Lokshin & Sajaia, 2011):

$$\begin{aligned}
ATT &= \frac{1}{N_0} \sum_{i=1}^{N_0} TT(x_i) \\
&= \frac{1}{N_1} \sum_{i=1}^{N_1} \left[\Pr(y_1 = 1 | D_i = 1, X = x) - \Pr(y_0 = 1 | D_i = 1, X = x) \right] \\
&= \frac{1}{N_0} \sum_{i=1}^{N_0} \left[\frac{\Phi_2(\beta_1 X_1, Z\gamma, \rho_1) - \Phi_2(\beta_0 X_0, Z\gamma, \rho_0)}{F(Z\gamma)} \right]
\end{aligned} \tag{4.28}$$

Where N_1 and N_0 denote the sample numbers for AC service participants and non-participants, respectively; $\Pr(y_1 = 1 | D_i = 1, X = x)$ is the probability of participant i adopting farm technology (actual probability for AC service participants) and $\Pr(y_0 = 1 | D_i = 1, X = x)$ is the probability of farm technology adoption for AC service participant i if the participant chose not to participate in AC services (a counterfactual probability for AC service participants). Φ_2 is the cumulative function of a bivariate normal distribution. F is a cumulative function of the univariate normal distribution.

ATU is the mean effect of the treatment effect on untreated (TU). TU is the expected effect of the treatment on households who did not participate in AC services. For example, the average effect of AC credit on farm technology adoption on untreated (ATU) can be calculated by averaging TU over non-AC credit participants. The effect of the AC credit on the untreated (TU) is the difference between the probability of farm technology adoption (outcome) for non-participant i if the participant borrowed AC credit (counterfactual probability) and the probability of farm technology adoption for non-participant i (actual probability). ATU can be express as follows (Lokshin & Sajaia, 2011):

$$\begin{aligned}
ATU &= \frac{1}{N_0} \sum_{i=1}^{N_0} TU(x_i) \\
&= \frac{1}{N_0} \sum_{i=1}^{N_0} \left[\Pr(y_1 = 1 | D_i = 0, X = x) - \Pr(y_0 = 1 | D_i = 0, X = x) \right] \\
&= \frac{1}{N_0} \sum_{i=1}^{N_0} \left[\frac{\Phi_2(\beta_1 X_1, -Z\gamma, -\rho_1) - \Phi_2(\beta_0 X_0, -Z\gamma, -\rho_0)}{F(-Z\gamma)} \right]
\end{aligned} \tag{4.29}$$

Where $\Pr(y_1 = 1 | D_i = 0, X = x)$ is the probability of farm technology adoption for non-participant i if the participant chose to participate in AC services (counterfactual probability of non-participants) and $\Pr(y_0 = 1 | D_i = 0, X = x)$ is the probability of farm technology adoption for non-participant i (a actual probability of non-participants).

4.3 Data Collection and Methods

4.3.1 Data Collection Method

Our study used a structured questionnaire to survey rural households in the Nakhonratchasima province, in Northeast Thailand. The field survey was conducted between November 2017 and February 2018. Our study chose the Nakhonratchasima province as the study site because it has the highest number of farmers (259,648 farmers) and agricultural land areas (6.6 million rais) in Thailand (National Statistical Office, 2013). Furthermore, this province had the greatest number of AC members (with 305,627 members and 99 ACs as of December 2018) (Cooperative Promotion Department, 2019).

The Nakhonratchasima province consists of 32 districts, 287 townships and 3,743 villages (Nakhonratchasima Provincial Governor's Office, 2016). Most of the rural population in the Nakhon Ratchasima province work in the agricultural sector. The Nakhonratchasima province can be divided into six areas, based on the provincial development plan and policy (see Table 4.2). The groups are divided in terms of geography and development potential. Since the study is interested in AC effects, one district from each group, which has the greatest number of AC members in the group, was selected for the study. District selection is explained in the sampling method section. The selected districts have 29 active ACs in 2016 (see Table 4.2). All ACs provide credit, however, only nine ACs offer non-credit support services such as purchasing, marketing, processing, and agricultural extension services. The rest of the ACs provide some types of non-credit support services (Nakhonratchasima Provincial Cooperative Office, 2016).

Table 4.2 Number of Agricultural Cooperatives and Members in the Nakhonratchasima Province in 2016 by District

Group	District	Number of Active ACs	Number of AC Members
1	Muang Nakhon Ratchasima	6	3,695
	Sikhui	4	3,746
	Pakchong*	6	6,681
	Sungnon	2	4,352
	Chaloemphrakiat	4	1,516
	Khamthaieso	4	1,801
2	Chokchai	2	3,676
	Pakthongchai*	8	192,764
	Wongnamkhieo	5	798
	Khonburi	7	5,103
	Soensang	4	1,900
3	Phimai*	3	13,857
	Chumphuang	3	8,397
	Nondaeng	1	980
	Prathai	2	2,466
	Lumthamenchai	1	590
	Muang yang	3	965
4	Chakarat	2	5,431
	Nonsong*	8	6,583
	Huaithalaeng	3	1,783
	Nongbunnak	3	1,555
	Nonthai	2	4,832
5	Dankhunthot*	3	8,196
	Tepharak	0	0
	Phrathongkham	0	0
	Khamsakaesaeng	1	2,985
6	Buayai*	1	10,962
	Bualai	2	1,214
	Kaengsnamrang	2	1,749
	Sida	0	0
	Banluarm	2	1,246
	Khong	2	4,287
Total		96	304,110
Total Number of Selected Areas (6 districts)		29	239,043

Source: Nakhonratchasima Provincial Cooperative Office (2016)

Note: * indicates selected districts of each zone with the greatest number of AC members in each group

4.3.2 Questionnaire Design

The household data was collected in 2017 using a structured questionnaire. The questionnaire was approved by the Lincoln University Human Ethics Committee. The original questionnaire was written in English, translated into Thai and then back translated to ensure accuracy. The survey questionnaire collected information about household demographics and economic characteristics, as well as information about AC accessibility and AC services (credit and non-credit support services).

The questionnaire consisted of four sections: (1) accessibility to ACs; (2) accessibility to AC credit and non-credit support services; (3) general farm information; (4) household demographic and economic characteristic. The first section was designed to capture AC accessibility and household perceptions of farm risk, AC performance, and expected AC benefits. This section measured farm risk in terms of three features: production risk, market risk, and financial risk. Respondents were asked to evaluate whether they faced risks and their risk levels. The scale ranged between '1' strongly disagree to '5' strongly agree. Strongly disagree indicated no risks while strongly agree indicated very high risks. Similarly, in terms of AC performance and benefits, respondents were asked to assess their interactions with ACs. The questions were related to their satisfaction with ACs and the effectiveness of AC support in the areas of credit and market access, income generation, technology adoption, and production improvement. The second section was designed to obtain information about AC services (credit and non-credit support services) and the characteristics of AC participants. The third section focused on agricultural activities and asked for specific information such as crop type, farm size, input use, yields, and the number of crops sold. The last section contained questions about respondents' demographic and economic characteristics, such as income, expenditure, and household member welfare in terms of education and health status.

4.3.3 Sampling Method

The study aims to evaluate the effect of AC credit and non-credit support programs using the ESR model. Effect estimation requires a large amount of data and a sufficient sample size, both for the control and treatment groups, so that the results can be applied to a larger population (Heinrich, Maffioli, & Vazquez, 2010). In this study, AC members are a small minority, in terms of the overall population (19% of total rural households). Therefore, to obtain the necessary sample size for both groups, the quota sampling method was applied (Sekaran & Bougie, 2016). Quota sampling ensures that the sample size in each group is adequate for effect evaluation. It is also more convenient in terms of effort, costs, and time. Furthermore, it is necessary to employ this method when a sample is a minority group (Sekaran & Bougie, 2016).

A two-stage stratified sampling technique was employed to select the rural household samples in order to obtain the best representatives. The first stage involves selecting one district from each group, by selecting the district which has the greatest number of AC members. Since the population for the study is rural households in the Nakhonratchasima province, Pakchong, Pakthongchai, Phimai, Nonsong, Dankhunthot, and Buayai were selected as study areas (see Table 4.2). Household selection from each district is covered in the second stage. The sample from each district was calculated using the disproportionate stratified random sampling method.

4.3.4 Sample Size

The household survey administered in Nakhonratchasima, the Northeast of Thailand.

Nakhonratchasima has 926,370 households in 32 districts (Official Statistics Registration Systems, 2016). Since population size is finite, the sample size is determined using Cochran's (1977) formula:

$$n_0 = \frac{z^2 pq}{e^2}$$

Where n_0 is the sample size; z^2 is the abscissa of the normal curve that cuts off an area at the tail; e is the desired level of precision; p is the estimated proportion of an attribute that is present in the population; and q is $1 - p$.

The level of confidence is determined to be 95%, where $z=1.96$ and $e=0.05$. p is assumed to be 0.5 (equal to $q = 0.5$). Following the results obtained from the Cochran formula, the study used a sample size of 385 farm households. The study surveyed 600 respondents to obtain the required number of responses for analysis. The respondents were classified into two groups based on their AC membership status. The rural households who participate in ACs were referred to as the AC member group; others who did not participate in ACs were referred as the non-AC member group.

To obtain the required number of samples for both the treatment and control groups, the quota sampling method was applied. This balances the sample size between both groups. Therefore, the study targeted 300 residents for both the treatment and control groups (see Figure 4.2). Household samples were chosen from each district using disproportionate stratified random sampling. Since the sample size of Pak Chong was too large, the study used disproportionate stratified random sampling to ensure that the sample size for each district is sufficient to obtain the accurate estimate and compare among the districts (Ross, 2005). The sample sizes from Pakchong, Pakthongchai, Phimai, Nonsong, Dankhunthot, and Buayai were 160, 94, 110, 76, 100, and 60, respectively (see Table 4.3). By balancing the treatment group and control group, the sample size in both the treatment and control group were equal, with 80 households from Pakchong, 47 households from Pakthongchai, 55 from Phimai, 38 households from Nonsong, 50 households from Dankhunthot, and 30 from Buayai.

Table 4.3 Number of Households in the Nakhonratchasima Province in 2016 by Study Sites

District	Number of Households	Number of Subjects in the Sample		Number of Sample (Disproportionate Sampling)	
		Proportionate Sampling (0.30% of households)	Disproportionate Sampling	Control Group	Treatment Group
Pakchong	59,309	180	160	80	80
Pakthongchai	29,811	90	94	47	47
Phimai	36,113	109	110	55	55
Nonsong	23,039	76	76	38	38
Dankhunthod	31,924	97	100	50	50
Buayai	17,765	54	60	30	30
Total	197,961	600	600	300	300

Source: Official Statistics Registration Systems (2016)

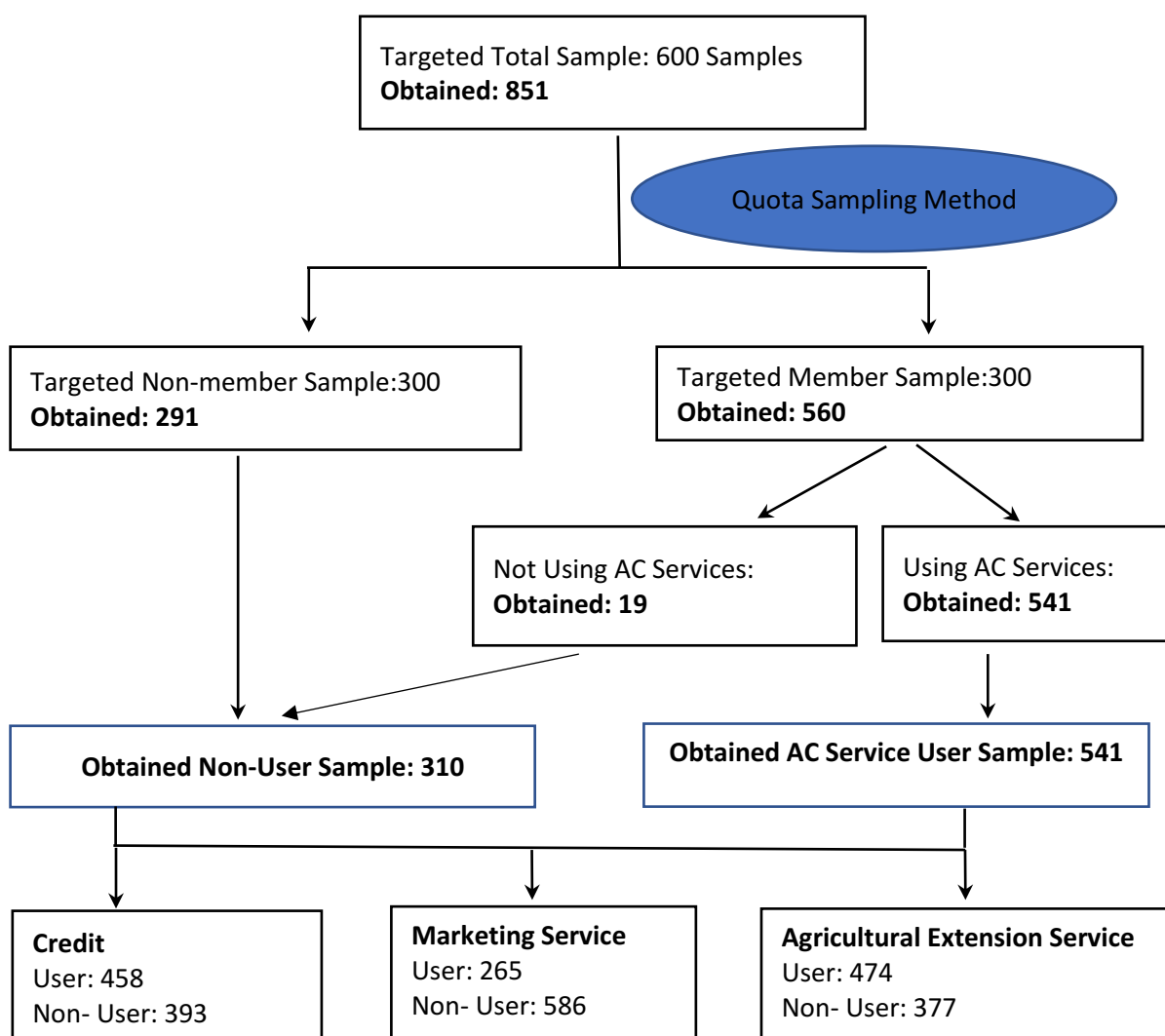


Figure 4.2 Proposed Framework for Sampling and Realization

Source: Author's calculation based on survey data

Our study evaluates the effect of credit and non-credit support services provided by ACs on household welfare. Regarding the AC service type, the survey targeted 300 respondents for treatment (user) and control (non-user) groups. However, during the survey administration, it was difficult to obtain 300 AC-members who use marketing services. To obtain a sufficient number of respondents in each group, particularly the marketing service user group, the study collected 851 rural households in the Nakhonratchasima province, in the Northeast of Thailand, using a structured survey questionnaire. The survey was administered in November 2017- February 2018. Respondents were grouped into non-AC and AC members. Out of the 851 households who participated, 560 (66%) were AC members, while 291 (34%) were non-members (see Figure 4.2). In terms of the AC credit, 458 respondents (59.46%) were AC members and borrowed credit from ACs in 2015, whereas, 393 respondents (46.18%) were non-AC credit users including 310 non-AC member and 83 AC members who did not borrow from ACs in 2015. In term of non-credit support services, 265 respondents (31.14%) were AC members and participated in AC marketing services. While 474 respondents (55.70%) were AC member participating in agriculture extension services (see Appendix C.1).

4.4 Profiles of Sampled Households in the Survey

This section describes the respondents' characteristics based on AC participation. The sampled respondents' characteristics include household head, household characteristics, and household perceptions of farm risks and expected benefits from AC participation. Frequency, mean and statistic tests were estimated to compare between the two groups of respondents. T-test is applied to compare the mean values of household characteristics of the two groups, AC and non-AC member groups. The Chi-square test is used to test the relationship between the non-metric household variables and AC participation.

4.4.1 Individual Characteristics

The respondents' individual characteristics are presented in Table 4.4. Gender and farm types are significantly different at the 1% level. Age is significantly different at the 5% level across the two household groups (AC members and non-AC members). In addition, the mean distribution of AC and non-AC members is significantly related to marital status and orchard farm at the 10% level. However, the household heads' educational level is not significant.

Most of the respondents were female (64.28%). The percentage of females in AC and non-AC member groups was more than 50%. The statistical test shows that female or male respondents differ significantly across the two household groups. In terms of age, Table 4.4 shows that most of the respondents were between 46 and 65 years old. Over 20% of the household heads were aged between 46 and 55, while 32.6% were between 56 and 65 years old. A considerable proportion of

non-AC members (58.77%) and AC-members (64.10%) fell into the 46 - 65 year-old category. The average age of the respondents was 55 years old. Although the average age of non-AC members (56 years old) and AC members (54 years old) was over 50 years, the statistical test indicates that the average age of non-AC members differs significantly from AC-members at the 5% level. There is a higher proportion of older respondents in the non-AC group (20.96%).

Most respondents (98.47%) had attained some level of education, mostly at the primary level (72.15%). The distribution of education levels between non-AC and AC-member groups is not significantly different. Over 70% of the respondents in both groups graduated from primary school, while 23% had completed further schooling/education, below the bachelor's degree level. The mean of educational years is not significantly different across the two groups (AC member and non-AC member groups).

Crops in Nakhonratchasima can be divided into three broad groups: paddy, cash crops, and orchards. Cash crops include cassava, corn, and sugarcane. Most of the respondents in both groups, (87.29% for non AC members and 69.64% for AC members) grew rice. Apart from rice, AC members grew fruit (8.59%), while non-AC members grew cash crops (13.04%). Our study finds that the distribution of paddy and cash crops for non-AC and AC member groups is significantly different at the 1% level.

4.4.2 Household Characteristics

Table 4.5 presents information about household population structure and economic status. The mean number of members, income earners, and children in household are not significantly different across the two groups. However, household wealth, measured by farm size, land ownership status, and household and farm income differs significantly across the two groups.

Generally, households have four members, three working adults with one child (1-15 years old). Fifty-three percent of the households had three to four members, followed by five to seven members (28%). The majority households (over 80%) had less than two children below 15 years old. The average number of income earners was three persons. The predominant number of income earners within a family was two to three persons (over 70%). These results indicate that younger members of the family (children below 15) may also work in order to earn money to attend school; they often leave school at the age of 15 to either help their parents or engage in full-time employment. In short, most family members are engaged in some form of work (full-time or otherwise). Income earners and children in a family do not differ across the two groups (AC member and non-AC member groups).

Table 4.4 Individual Characteristics

Individual Characteristics	Non AC-Member (N ₁ =291)		AC-Member (N ₂ =560)		All Respondents (N=851)		Statistical Test
	Count	% of N ₁	Count	% of N ₂	Count	% of N	
<i>Gender</i>							
Female	170	58.42	377	67.32	547	64.28	$\chi^2 = 6.609^{***}$
Male	121	41.58	183	32.68	304	35.72	
Total	291	100	560	100	851	100	
<i>Age Group (years)</i>							
Less than or equal to 25	2	0.69	0	0	2	0.24	$\chi^2 = 14.646^{**}$ t= 2.2422**
26-35	12	4.12	19	3.39	31	3.64	
36-45	45	15.46	105	18.75	150	17.63	
46-55	73	25.09	179	31.96	252	29.61	
56-65	98	33.68	180	32.14	278	32.67	
Over 66	61	20.96	77	13.75	138	16.22	
Total	291	100	560	100	851	100	
Mean (S.E)	55.70	(0.70)	53.94	(0.44)	54.54	(0.37)	
<i>Marital Status</i>							
Single	20	6.87	17	3.04	37	4.35	$\chi^2 = 6.947^*$
Married	241	82.82	478	85.36	719	84.49	
Widowed	19	6.53	40	7.14	59	6.93	
Divorced	11	3.78	25	4.46	36	4.23	
Total	291	100	560	100	851	100	
<i>Education Level</i>							
No Education	4	1.37	9	1.61	13	1.53	$\chi^2 = 5.287$ t=0.4672
Primary School	206	70.79	408	72.86	614	72.15	
Middle School	30	10.31	45	8.04	75	8.81	
High School	29	9.97	66	11.79	95	11.16	
Vocational Training	9	3.09	18	3.21	27	3.17	
Bachelor's Degree	13	4.47	13	2.32	26	3.06	
Postgraduate	0	0	1	0.18	1	0.12	
Total	291	100	560	100.0	851	100	
Mean (S.E) (years)	6.44	(0.21)	6.36	(0.15)	6.36	(0.12)	
<i>Farm Type (Choose more than one)</i>							
Paddy	254	87.29	390	69.64	644	75.68	$\chi^2 = 32.38^{***}$
Cash-Crop	17	5.84	73	13.04	90	10.58	$\chi^2 = 75^{***}$
Orchard	25	8.59	29	5.18	54	6.35	$\chi^2 = 3.75^*$
Others	4	1.38	10	1.79	14	1.65	$\chi^2 = 0.446$

Note: Computed by the authors using 2017 survey data.

Table 4.5 Household Characteristics

Household Characteristics	Non AC-Member (N ₁ =291)		AC-Member (N ₂ =560)		All Respondents (N=851)		Statistical Test
	Count	% of N ₁	Count	% of N ₂	Count	% of N	
<i>Household Size (Members)</i>							
1-2	50	17.18	93	16.61	143	16.8	$\chi^2 = 0.552$ t = -0.320
3-4	157	53.95	298	53.21	455	53.47	
5-7	82	28.18	158	28.21	240	28.2	
8 and more	2	0.69	11	1.96	13	1.53	
Total	291	100	560	100	851	100	
Mean (S.E)	3.88	(0.08)	3.91	(0.06)	3.90	(0.05)	
<i>Income Earner (Members)</i>							
1	27	9.28	57	10.18	84	9.87	$\chi^2 = 0.749$ t=1.524
2-3	208	71.48	406	72.5	612	71.92	
4 or More	56	19.24	97	17.32	153	17.98	
Total	291	100	560	100	851	99.77	
Mean (S.E)	2.64	(0.06)	2.53	(0.04)	2.57	(0.04)	
<i>Children (Members)</i>							
No Children	154	52.92	276	49.29	430	50.53	$\chi^2 = 0.373$ t=-1.552
1	91	31.27	178	31.79	269	31.61	
2-3	45	15.46	98	17.5	143	16.8	
4 or More	1	0.34	8	1.43	9	1.06	
Total	291	100	560	100	851	100	
Mean (S.E)	0.65	(0.05)	0.72	(0.04)	0.71	(0.03)	
<i>Farm Size (ha)</i>							
Less than 0.96	57	19.59	41	7.32	98	11.52	$\chi^2 = 0.000$ t=-5.7491***
0.96 to less than 1.6	42	14.43	53	9.46	95	11.16	
1.6 to less than 6.4	166	57.04	342	61.07	508	59.69	
6.4 to less than 22.4	26	8.93	118	21.07	144	16.92	
22.4 or More	0	0	6	1.07	6	0.71	
Total	291	100	560	100	851	100	
Mean (S.E)	2.87	(0.18)	4.56	(0.19)	3.98	(0.14)	
<i>Land Holding Status</i>							
Owned Land	206	71.03	340	61.04	546	64.46	$\chi^2 = 10.599^{**}$ $\chi^2 = 1.792$ $\chi^2 = 3.736^{**}$ $\chi^2 = 153.426^{***}$ $\chi^2 = 5.665^{**}$
Leased Land	3	1.03	4	0.72	7	0.83	
Rental Land	73	25.17	179	32.14	252	29.75	
State Land	8	2.76	34	6.1	42	4.96	
Irrigation Access	117	40.21	252	45.00	369	43.36	
Technologies Access	118	40.55	266	47.50	384	45.12	
Credit Demand	143	49.14	493	88.04	636	74.74	
Credit Access	139	96.53	489	99.19	628	98.59	

Table 4.5 Household Characteristics (Cont.)

Household Characteristics	Non AC-Member (N ₁ =291)		AC-Member (N ₂ =560)		All Respondents (N=851)		Statistical Test
	Count	% of N ₁	Count	% of N ₂	Count	% of N	
<i>Household Income (Thai baht)</i>							
Inc_Pr (<20,000)	9	3.09	3	0.54	12	1.41	
Inc_UPr (20,001 to 100,000)	82	28.18	118	21.07	200	23.5	
Inc_NPr (100,001 to 500,000)	169	58.08	371	66.43	541	63.57	
Inc_Ri (> 500,000)	31	10.65	60	11.96	98	11.52	
Total	291	100	560	100	851	100	$\chi^2=15.389^{**}$
Mean (S.E)	264,995 (23,188)		311,827 (21,712)		295,813 (16,350)		t=-1.359
<i>Farm Income (Thai baht)</i>							
Inc_Pr (<20,000)	128	43.99	123	21.96	251	29.49	
Inc_UPr (20,001 to 100,000)	107	36.77	223	39.82	330	38.78	
Inc_NPr (100,001 to 500,000)	56	19.24	214	38.21	270	31.73	
Total	291	100	560	100	851	100	$\chi^2=53.667^{***}$
Mean (S.E)	114,277 (21,027)		183,241 (21,518)		159,658 (15,913)		t=-2.060**

Note: 1. Computed by the authors using 2017 survey data.
2. Farm size is grouped following the Thailand Agriculture Census.
3. 1 hectare equals 6.25 rai.

The average respondent's farm size was 3.98 ha. A significant proportion of respondents (60%) hold more than 1.6 but less than 6.4 ha. The AC members' farm size significantly differs from non-AC members at the 1% level. AC members have farms of greater size than non-AC members. The average farm size of the AC member group was around 4.5 ha, while non-AC members had 2.87 ha. Over 60% of the total respondents owned land and 40% had access to irrigation and adopted farm production technologies.

Land ownership and technology access are significantly different between AC and non-AC member groups at the 5% level. The number of AC members who own land (around 61%) is less than non-AC members holding land (around 71%). The number of AC members accessing technology (47.50%) is more than non-AC members (40.55%).

Regarding credit, approximately 75% of the respondents attempt to access loans. Among the respondents requiring credit, approximately 99% of households with credit demand were able to access loans. The high level of credit access can be attributed to Thailand's official fiscal policy. The Thai government continuously enhances credit accessibility for Thai citizens, particularly for those unable to access formal credit sources (Microfinance Services Ltd, 2013). Credit demand and credit access differ significantly between AC and non-AC member groups. The findings indicate that households want to participate in ACs because they wish to access credit. Over 80% of AC members wished to borrow money (see Table 4.5) and they strongly believed that ACs could increase their credit access and supports them in spending loans for income generation activities at a high level,

4.26 and 3.89, respectively (see Table 4.7). Moreover, the number of AC members accessing credit (99.19%) is more than non-AC members (96.53%). This suggests that both AC and non-AC members do not experience liquidity constraints.

Average household annual income equates to 295,813 baht, of which 54% is earned from farm activities with the remainder of income coming from other sources. Total household income in the study includes income from farm work, off-farm employment, and other income sources such as transfer payments and government subsidies such as subsistence allowance for the elderly and farmers (e.g. the spending 1,000 Baht Per rai project and the harvest subsidy project). Most of the households (63.57%) earned annual income between 100,000 and 500,000 baht. However, regarding farm income, almost 30% of the respondents were classified as poor since their income fell below the poverty line. Around 39% of the respondent were vulnerable to falling back into poverty. The survey data shows that off-farm work and other income is essential for rural households. Comparing AC and non-AC member groups, the greatest portion of AC members (66.43%) and non-AC members (58.08%) have annual household incomes between 100,001 and 500,000 baht. However, the statistical results reveal that AC members' household income is significantly different from non-AC members at the 5% level. The percentage of AC members who are in the poor and the near-poor group is smaller than those of non-AC members. Similarly, farm incomes between these two groups are significantly different at the 1% level. Most non-AC members were classified as poor (43.99%), while most of the AC members fell into the near-poor (39.82%) and not-poor (38.21%) categories.

4.4.3 Household Perceptions of Risks and AC Benefits

Table 4.6 shows the household perceptions of agricultural risk. The mean score of agricultural risks was 2.60, a mid-level. The average household perceptions of agricultural risk differs significantly across AC and non-AC member groups at the 1% level. Non-AC members have a lower level of agricultural risk (2.53) than AC members (2.64). The main difference occurs within financial risk. The financial risk of both AC and non-AC members differs significantly at the 1% level. AC members confront a higher level of financial risk than non-AC members. This is because most households participate in ACs because they need help in credit access. Similarly, the farm production risk is significantly different across two groups at the 10% level. Non-AC members face higher levels of farm production risk than AC members. Interestingly, the market risk is not statistically different between the two groups, indicating that both confront a similar level of market risk.

Table 4.6 Household Perceptions of Risk

Household Perceptions	Non AC-Member (N ₁ =291)	AC-Member (N ₂ =559)	All Respondent (N=850)	Statistical Test		
	Mean	Mean	Mean	Diff	S.E.	t statistic
Production Risks	3.03	2.93	2.97	0.09	0.06	1.6983*
Market Risks	2.25	2.30	2.28	-0.05	0.06	-0.8939
Financial Risks	2.30	2.69	2.56	-0.39	0.07	-5.2619***
Total Agriculture Risk	2.53	2.64	2.60	-0.11	0.04	-2.8295***

Note: Computed by the authors using 2017 survey data.

In this study, household perception includes AC performance and expectations about potential benefits. AC performance is measured in terms of AC satisfaction and effectiveness. AC benefits include credit, marketing, and agricultural extension services. Table 4.7 discloses that the respondents are satisfied with AC management and their effectiveness in the high level, with a range between 3.88 and 4.27. While the level of AC member perceptions of AC effectiveness is higher than non-members, AC satisfaction is not significantly different (Table 4.7).

Moreover, members believe that ACs assist them with credit, input, and output markets access, using loans to generate income, and support technology adoption. On a whole, respondents think that AC participation increases their credit access and supports them in spending loans for income generation activities at a high level, with mean scores of 4.16 and 3.83, respectively. These perceptions of credit benefits differ considerably across the two groups. AC members strongly believe that they benefit from credit access and income generation. Similarly, on average, the average scores of input and output marketing benefit perceptions were 3.90 and 3.91, respectively. In short, AC members strongly believe that ACs improve their input and output market accessibility, more than non-AC members, at the 5% level. These results indicate a strong relationship between household benefits of AC credit and marketing services and a family's decision to participate. However, there is no difference in the two groups in relation to information access. In terms of agricultural extension services, respondents believe that ACs can assist them with improving their production and technology adoption in the middle level, with average scores of 3.19 and 2.95, respectively. Likewise, in terms of production improvements, the average level of benefits does not differ across the two groups (AC and non-AC member groups). However, AC members' technology adoption benefit is higher than non-AC members at the 10% level.

Table 4.7 Household Perceptions of AC Performance

Household Perception of ACs	Non AC-Member (N ₁ =291)			AC-Member (N ₂ =559)			All Respondents (N=850)			Diff	S.E.	t-Statistic
	N/A (% of N ₁)	Yes (% of N ₁)	Mean	N/A (% of N ₂)	Yes (% of N ₂)	Mean	N/A (% of N)	Yes (% of N)	Mean			
<i>Perceptions of AC Performance</i>												
Satisfaction	73 (25.09%)	218 (74.91%)	4.19	1 (0.18%)	559 (100%)	4.30	74 (8.71%)	777 (91.41%)	4.27	-0.11	0.07	-1.5637
Effectiveness	58 (19.93%)	233 (80.07%)	3.75	19 (3.40%)	541 (96.78%)	3.93	77 (9.06%)	774 (91.06%)	3.88	-0.18	0.08	-2.3134**
<i>Credit Benefits</i>												
Credit Access	30 (10.31%)	261 (89.69%)	3.95	1 (0.18%)	559 (100%)	4.26	31 (3.65%)	820 (96.47%)	4.16	-0.31	0.07	-4.5311***
Income Generation	54 (18.56%)	237 (81.44%)	3.70	5 (0.89%)	555 (99.28%)	3.89	59 (6.94%)	792 (93.18%)	3.83	-0.19	0.08	-2.2421**
<i>Marketing Benefits</i>												
Input Market Access	70 (24.05%)	221 (75.95%)	3.71	40 (7.16%)	520 (93.02%)	3.98	110 (12.94%)	741 (87.18%)	3.90	-0.27	0.08	-3.1527**
Output Market Access	71 (24.40%)	220 (75.60%)	3.77	69 (12.34%)	491 (87.84%)	3.97	140 (16.47%)	711 (83.65%)	3.91	-0.20	0.09	-2.3206**
Information Access	56 (19.24%)	235 (80.76%)	3.39	3 (0.54%)	557 (99.64%)	3.40	59 (6.94%)	792 (93.18%)	3.40	-0.01	0.10	-0.0507
<i>Agricultural Extension Benefits</i>												
Production Improvement	55 (18.90%)	236 (81.10%)	3.22	9 (1.61%)	551 (98.57%)	3.18	64 (7.53%)	787 (92.59%)	3.19	0.04	0.09	0.4240
Technology Adoption	52 (17.87%)	239 (82.13%)	3.08	10 (1.79%)	550 (98.39%)	2.89	62 (7.29%)	789 (92.82%)	2.95	0.19	0.11	1.8095*

Note: Computed by the authors using 2017 survey data.

4.4.4 Household Participation in AC Services

Table 4.8 shows that ACs contribute to household welfare through AC credit, agricultural extension services, and funeral services. The survey results show 458 of AC members (81.79%) borrowed money from ACs and 474 of AC members (84.64%) joined agricultural extension services. They received help and support from the funeral fund (83.39% of AC members). They pay premiums life insurance that can be used when a family member dies. Moreover, the funeral fund can be used as loan collateral. However, few AC members trade to ACs. There are 44.46% of AC members who purchase farm inputs from ACs. Likewise, only 17.86% sell their farm products to ACs.

AC borrowers are able to borrow money from ACs through group or individual lending. The survey results show 50.34% of the borrowers borrowed as a group (co-guarantors) rather than as an individual (see Table 4.9). Others used their land or home as collateral (53.29% of the total number of AC borrowers). Most AC loans were used for farm production (98.69%). They were often short-term loans (91.27%) with an interest rate of 8.16%. Interestingly, 323 of AC borrowers (70.52%) were also able to access loans from other credit sources. This result shows that ACs are complimentary credit sources for households since some of AC borrowers have multiple forms of credit – from BAAC, the village fund, and ACs.

Table 4.9 shows that 249 of AC members (44.46%) purchased farm inputs via ACs, and 100 (17.86%) sold their farm products to ACs. Most AC input participants purchased fertilizers (90.36%), pesticides or agrochemicals (38.15%), as well as seeds and saplings (36.95%). The most popular payment method was credit (57.43%). In terms of output marketing participants, 55% of output marketing participants sold their farm outputs to ACs, while 45% of those sold their farm products to a variety of sources; both ACs and other market channels (individual selling, dealer, and state agency). Most AC output marketing participants (87%) received AC sale revenue on time.

4.5 Chapter Summary

To summarize, the chapter provides the empirical model specifications and data that were used to answer the research objectives of the thesis. Three empirical models were discussed in this chapter. First, the probit model was performed to identify which determinants influence households to participate in AC membership. Second, among AC members, the Heckman selection model was specified to identify determinants of participation in AC services in terms of participation decision and participation level. The model is expected to provide consistent estimators for the determinants of AC members' decision to participate in AC services and level of participation under the selection bias. Finally, the ESR model was conducted for AC effect evaluation. The ESR also provides determinants of AC service participation and household welfare. The ESR model is expected to

achieve consistent estimators under the selection bias arising from both observed and unobserved factors.

The data used for the analysis is primary data collected through a structured questionnaire. The survey was administered to rural households in the Nakhonratchasima province, in Northeast Thailand. Nakhonratchasima was categorized into six area groups following the provincial development plan and policy. The rural household samples were selected using a two-stage stratified sampling technique. The first stage was the selection of districts. Our study selected a district which has the largest number of AC members in a group. The second stage involved selecting the households from each district. The sample size of each district was calculated using the disproportionate stratified random sampling method. The survey yielded a total of 851 useable questionnaires.

Table 4.8 AC Members' Participation in AC Services

AC Membership	Non-Participation		Participation		Total
	Number	%	Number	%	
AC Services					
Credit	102	18.21	458	81.79	560
Input Marketing Services	311	55.54	249	44.46	560
Output Marketing Services	460	82.14	100	17.86	560
Agricultural Extension Services	86	15.36	474	84.64	560
AC Social Services					
Services for Education Support	543	96.96	17	3.04	560
Services for Health Support	557	99.46	3	0.54	560
Funeral Fund	93	16.61	467	83.39	560

Note: Computed by the authors using 2017 survey data.

Table 4.9 AC Service Attribute

AC Services	No		Yes		Total
	Number	%	Number	%	
AC Credit Participation (N=458)					
Other Loans	135	29.48	323	70.52	458
Purpose					
Farm Activities			452	98.69	
Non-Farm Activities			6	1.31	
Duration					
Short-Term Loans			418	91.27	
Mid-Term Loans			20	4.37	
Long-Term Loans			20	4.37	
Collateral Requirement (Choose more than one)					
	20	4.37	438	95.63	458
Mortgage Property (i.e., House, Land)	206	46.71	235	53.29	441
Chattels Mortgage	440	99.77	1	0.23	441
Co-Guarantors	219	49.66	222	50.34	441
Deposits	439	99.55	2	0.45	441
Loan Amount (Mean(S.E.))			149,690	(165,154)	
Interest Rate (%/year)			8.16	(0.93)	
AC Input Marketing Service Participation (N=249)					
Purchasing from Other Suppliers	98	39.36	151	60.64	249
Input Types					
Seeds and Saplings	157	63.05	92	36.95	249
Fertilizers	24	9.64	225	90.36	249
Pesticides or Agro Chemicals	154	61.85	95	38.15	249
Others (Fuel)	188	75.50	61	24.50	249
Payment Method					
By Cash			72	28.92	249
On Credit			143	57.43	249
Part Cash and Credit			34	13.65	249
Input Expenses (Thai baht) (Mean(S.E.))			22,110	(29,117)	
AC Output Marketing Service Participation (N=100)					
Selling Products to Other Markets	55	55.00	45	45.00	100
Receiving Delayed Payments	87	87.00	13	13.00	100
Sale Amount (tons)			239.40	57.38	
AC Sale Share (Mean(S.E.))			0.67	(0.42)	

Note: Computed by the authors using 2017 survey data.

Chapter 5

Determinants of Households Participation in AC Credit and non-Credit Support Services

This chapter presents the empirical results of the models for participation in AC membership, AC credit, and non-credit support services. It uses primary data collected from rural households in the Nakhonratchasima province, in the Northeast of Thailand. The chapter is divided into three sections. Section 5.1 presents the empirical model and results of diagnostic tests to obtain consistent and efficient coefficients in the Heckman selection model. Section 5.2 discusses the results of the AC participation models. Section 5.3 summarizes the results.

5.1 Model Specification

5.1.1 Empirical Model

Our study explores the determinants of participation in AC and AC services, taking the selection bias into account. Our study examines both participation and levels of participation in AC services. Our study applies the probit model to identify participation factors in AC membership and agricultural extension services. Factors influencing households to participate in AC credit and AC marketing services are identified using the Heckman selection model.

The Heckman selection model consists of two stages; the participation or selection process and the outcome process. First, household probability of participation in ACs and AC services is estimated. The household probability to participate in AC and AC services is given by equation (5.1).

$$D_i^* = \delta z_i + \varepsilon_i$$
$$D_i = \begin{cases} = 1, & \text{if } D_i^* > 0 \\ = 0, & \text{if otherwise} \end{cases} \quad (5.1)$$

Where D_i is a binary outcome, $D_i=1$ indicates that households decide to participate in AC and AC services, and $D_i=0$ if households do not. Explanatory variables (z_i) are observable factors which influence the utility. δ is a vector of parameters. The error term (ε_i) captures unobservable factors affecting utility but are not included in the explanatory variables. The error term is assumed to be normally distributed with a zero mean.

The second stage analyses the level of participation in AC credit and marketing services. The level of participation is measured by loan size, input expenditure, and the quantity of farm products sold

through ACs. Participation level is estimated using information provided by households who participate in the first stage. Participation levels for AC services are expressed by equation (5.2):

$$y_i = \beta x_i + \mu_i, \text{ Given } D_i \text{ equals one} \quad (5.2)$$

Where x_i is a vector of explanatory variables determining participation levels in AC services (y_i), and (μ) is an error term. The error terms (ϵ , μ) are bivariate, normally distributed with zero means. If both error terms are correlated, the expected value of μ conditional on the sample selection are non-zero which is denoted by $E(\mu|\epsilon) = \gamma\epsilon$. The level of AC service participation (y_i) is observed only when the household participates in AC services ($D_i=1$).

Our study applies the probit model (equation 5.1) to estimate the probability of participation in ACs and AC agricultural extension services. Regarding AC services, the Heckman selection model is used to examine the determinants influencing participation. Our study considers three AC services; credit, input and output marketing services. Thus, there are three Heckman selection models in our study. The Heckman selection model for each AC service consists of a participation equation (equation 5.1) and a participation level equation (equation 5.2). The dependent variable (y_i) in the participation level equation for AC credit is loan amount. The dependent variable for AC input marketing service is input expenses through ACs and for output marketing service is farm product quantity sold to ACs. These systems of equations can be estimated using the Heckman two-stage approach.

All dependent and explanatory variables used in the participation model for AC membership, AC credit, AC input marketing service, AC output marketing services, and AC agricultural extension services are described in Table 5.1. Table 5.1 provides names, descriptions, and the study's hypotheses.

Prior studies on AC participation report that participation in ACs and AC services is determined by several individual and household characteristics. For example, the age and education of individuals can have a positive and negative impact on participation since they imply risk preferences and different levels of understanding about AC benefits (Alene et al., 2008; Chagwiza et al., 2016; Ferto & Szabo, 2002, Fischer & Qaim, 2012; Muthyalu, 2013).

Among farm types, rice growers are less likely to join AC services, particularly input and marketing services, since they have more government support. Similarly, fruit and vegetable growers are less likely to participate in ACs. This may be because orchards are not common in Nakhonratchasima province, thus none of the ACs support orchard operations. However, farmers engaged in cash crops tend to join ACs since these are the primary crops grown in this province.

In terms of household characteristics, farm size may have a positive impact on AC participation, especially in terms of middle-class farmers (Bernard & Spielman, 2009; Fischer & Qaim, 2012). This finding indicates that very small or large farmers do not tend to participate in ACs. ACs are not interested in working with small farmers because they increase AC costs. They have various interests and their production is small therefore increase in the number of small farm members increases AC's operation cost (Bernard & Spielman, 2009). In contrast, large farmers are wealthy and, as a result of their production quantity, have greater bargaining power. They are more likely to benefit from selling their produce individually and thus unlikely to join ACs (Fischer & Qaim, 2012). In terms of participation levels, farm size should have a positive impact on loan size, farm input expense, and sale amount via ACs since farm size refers to production scale. The larger the farm is, the greater the financial capital and input quantity farmers require to invest in farm production. Similarly, farmers with large productions have higher volumes of farm products to sell.

In this study, the income variable is used to assess the level of poor households. Income level is grouped into four groups. Firstly, the poor group (Inc_Pr) covers those households which have income lower than 20,000 baht/year. Households in the first group are poor since their income is lower than the international poverty line (US\$ 1.90 per day or 56 baht/day). Secondly, the near poor group (Inc_UPr) refers to households which have income levels between 20,001 and 100,000 baht/year. Households in the near poor group are vulnerable to falling back into poverty and their income is lower than Thailand's minimum wage (300 baht/day or USD 9.68). The third group (Inc_NPr) covers households which earn between 100,001 and 500,000 baht/year. The last group, the rich (Inc_Ri), covers those households whose income is over 500,000 baht/year. Our study uses the wealthy group as a reference dummy. Income level is hypothesized to positively impact AC participation. A poor household may have a higher probability of joining an AC and AC services since the aim of these cooperatives is to assist lower income households to access credit and markets. Thus the income level variable can be used to monitor the effective implementation of ACs.

Risks or uncertainties are critical factors which influence agricultural production. Rural households confront various risks such as climatic uncertainty, unstable input and output prices, market changes, and innovations in production technologies. These difficulties or production and sale risks, and lack of funds significantly influence farmers' decisions to participate in ACs and AC services (Hoken, 2016; Hoken & Su, 2015; Ito et al., 2012; Zheng et al., 2011). Our study examines agricultural risks. Based on Aditto's (2011) analysis of farm risk factors in Thailand, our study classifies agricultural risks into three sources, farm production risks (Prod_Risk), market risks (Mkt_Risk), and financial risks (Fin_Risk). Risks are measured using numerical and self-evaluated variables. Households were asked to rate the risk levels in terms of their farm operations. The self-evaluated risk indicators are measured using a five-point Likert scale, ranging from 1=no risk to 5= extremely high risk.

Table 5.1 Determinants of Participation in ACs and AC Services

Variable	Description	Hypothesis for Participation in AC							
		Member	Credit		Input Marketing		Output Marketing		Agri Extension
			Participation	Loan Size (Log)	Participation	Input Expenses (Log)	Participation	Sale Quantity (Log)	
Household Head Characteristics									
Age_Yr	Age of Household Head (Years)	+	+/-	-	-	+	+/-	+	+/-
Sex	Gender of Household Head (1=Male,0=Female)	+/-	+/-						+/-
Edu_Yr	Education Level of Household Head (Years)	+	+/-	+	-		+/-	+	+
Paddy	1 if Household Grows s Rice, 0 Otherwise	-	-		-		-		
Cash_Crop	1 if Household Grows a Cash Crop, 0 Otherwise. Cash Crops include Sugar Cane, Cassava, or Corn.	+	+		+		+		
Orchard	1 if Household Grows Orchard, 0 Otherwise. Orchard in our Study include Fruit and Vegetables.	-	-		-		-		
Household Characteristics									
Inc_Earner	Number of Income Earners (Persons)	+/-							
Farm_Mem	Number of Household Members Working on Farm (Persons)		+	+/-	-	-	+		+
Farm_Si	Size of Agricultural Land (Rais)	+/-	+	+	+	+/-	+/-	+	+/-
Farm_Sq	Size of Farm Squared	-	-		-		-		
Land	1 if Household Owns Land, 0 Otherwise								+
Farm_Ass	1 if Household Owns Productive Assets, 0 Otherwise. Productive Assets include Farm Tools and Farm Machinery.		+	+					
Household Annual Income Level									
Inc_Pr	1 if Household Income is Below 20,000 baht/year, 0 Otherwise. Thai poverty Line is Income Below 20,000 baht/year.	+							
Inc_UPr	1 if Household Income is Between 20,000 baht and 100,000 baht/year, 0 Otherwise.	+							
Inc_NPr	1 if Household Income is Between 100,000 baht and 500,000 baht/year, 0 Otherwise	+							
Inc_Ri	1 if Household Income is over 500,000 baht baht/year, 0 Otherwise (Reference Dummy)								
Farm_Inc	Household Annual Income Gained from Farm Work (baht/year)					+			

Table 5.1 Determinants of Participation in ACs and AC Services (cont.)

Variable	Description	Hypothesis for Participation in AC							
		Member	Credit		Input Marketing		Output Marketing		Agri Extensi on
			Particip ation	Loan Size (Log)	Participa tion	Input Expenses (Log)	Particip ation	Sale Quantity (Log)	
FarInc_PU	1 if Household Farm Income is Below 100,000 baht/year, 0 Otherwise. This Indicates that the Poor and Vulnerable Households may Fall Back into Poverty	+					-		
Commer Off_Farm	Agricultural Commercialization (Ratio of Sale to Yield) 1 if Household Member Works in Off-farm Activities, 0 Otherwise						+	+	
Cre_Use	1 if Household Accesses Credit, 0 Otherwise	+					+	+	
Oth_loan	Loan Amount Borrowed from Other Lenders Except ACs (Baht)		+						
Ext_Acc	1 if Household Accesses Agricultural Extension Services, 0 Otherwise	+	+						
Irr_Acc	1 if Household Accesses Irrigation, 0 Otherwise				+			+	
Tech_Acc	1 if Household Adapts Technology in Farm Production, 0 Otherwise				+				
Household Perceptions of Risks and AC Benefits (Scale from 1 to 5)									
Pro_Risk	Farm Production Risks including Weather, Pests, Infertile Soil, Late Delivery of Supplies, and Lack of Labour	+						+	
Mkt_Risk	Market Risks including Competing Growers, Changes in Consumer Preferences, Low Product Quality, Loss the Market, Failure to Access Market Information	+			+		+		
Fin_Risk	Financial Risks including Insufficient Cash to Meet Expected Obligations, Increased Input Costs and Interest Rates, Excessive Borrowing, and Failure to Fulfil Business Agreements	+	+	-	+		+/-		
Sat	Satisfaction with AC Management	+						+	
Eff	AC Effectiveness	+						+	
Cre_Be	Credit Benefit Obtained from ACs including Credit Access and Income Generation Support	+							
CreAcc_Be	ACs Increase Credit Access		+						
IncGen_Be	ACs Support Borrowers to Spend Loans for Income Generating Activities		+						
Inp_Acc	ACs Facilitate Households to Access Farm Inputs with Fair Price and Standard Service	+			+				

Table 5.1 Determinants of Participation in ACs and AC Services (cont.)

Variable	Description	Hypothesis for Participation in AC							
		Member	Credit		Input Marketing		Output Marketing		Agri Extension
			Participation	Loan Size (Log)	Participation	Input Expenses (Log)	Participation	Sale Quantity (Log)	
Out_Acc	ACs Facilitate Households to Access Product Markets with Fair Price and Standard Service	+					+		
Ext_Be	Benefits Obtained from Participating in AC Agricultural Extension Service include Improvements in Farm Production and Introducing New Farm Technologies	+							
Prod_Be	ACs Assist Households to Improve Farm Production							+	
Tech_Be	ACs are Effective in Introducing New Farm Technologies							+	
Inf_Acc	ACs Increase Households’ Access to Market Information	+					+	+	
AC Attributes									
AC_Share	Number of AC Shares Owned by Household (baht)		+		+		+		
ACdis	Distance from House to AC Centre (Kilometres)				-		-		
ACdur_Sh	Borrowing Short-term Loan (1 if Loan Duration is les than 12 Months, 0 Otherwise) (Reference Dummy)								
ACdur_Med	Borrowing Mid-term Loan (1 if Loan Duration is between 12 Months and 36 Months, 0 Otherwise)		+						
ACdur_Long	Borrowing Long-term loan (1 if Loan Duration is over 36 Months, 0 Otherwise)		+						
Coll_Prop	1 if Household uses Assets, Land or House as Collateral when Borrowing Credit from ACs, 0 Otherwise		+						
ACInp_Cre	1 if Household Purchases Inputs on Credit from AC, 0 Otherwise				+				
AC_P	The Average Price Offered by ACs (baht/kg.)						+		
ACothsale	1 if Household Sells Farm Products to Other Market Channel, 0 Otherwise						-		

Table 5.1 Determinants of Participation in ACs and AC Services (cont.)

Variable	Description	Hypothesis for Participation in AC							
		Member	Credit		Input Marketing		Output Marketing		Agri Extensi on
			Particip ation	Loan Size (Log)	Participa tion	Input Expenses (Log)	Particip ation	Sale Quantity (Log)	
Geographic and Related Factors									
Districts									
Dist_N	1 if Household Resides in the Northern Districts of Nakhon Ratchasrima (Phimai, Buayai, Nonsong Districts), 0 Otherwise	+	Y		Y		Y	Y	
Dist_C	1 if Household Resides in Dankhuntod District, 0 Otherwise (Reference Dummy)		Y		Y		Y	Y	
Dist_S	1 if Household Resides in the Southern Districts of Nakhon Ratchasrima (Pakchong and Pakthongchai Districts), 0 Otherwise	-	Y		Y			Y	
Dis_Town	Distance from House to the Nearest Town (Kilometers)		-						
AC_Rela	1 if Household’s Relatives are AC Members, 0 Otherwise	+							
AC_Vill	1 if There is a AC in Household’s Residing Village, 0 Otherwise	+			+		+	+	
Com_Att	1 if Household was Sought a Neighbour’s Opinion when Making the Decision Regarding AC Participation, 0 Otherwise		+		+				
Dependent Variable									
AC_Mem	1 if Household is AC member, 0 Otherwise	Y							
AC_Cre	1 if Household Participates in AC Credit, 0 Otherwise		Y						
ACcre_No	Amount of AC Credit Borrowed by Household (Baht) (Log Form)		Y						
AC_Inp	1 if Household Participates in AC Input Marketing Service, 0 Otherwise				Y				
ACInp_Ex	Input Expense via AC Input Marketing Service. Inputs include Seeds, Saplings, Fertilizer, and Pesticides (Baht) (Log Form)				Y				
AC_Mkt	1 if Household Participates in AC Output Marketing Services, 0 Otherwise						Y		
AC_Sale	Number of Farm Products Sold through ACs (Kilogram)(Log Form)						Y		
AC_Ext	1 if Household Participates in AC Agricultural Extension Services, 0 Otherwise							Y	

Farm production risks directly influence farm profitability, quantity and quality of farm production (Aditto, 2011). In this study, production risks consist of adverse weather, pests, infertile soil, the late delivery of supplies, and a lack of labour (see Table 5.1). Production risks are hypothesized to have a positive relationship with AC participation. Farmers who confront high production difficulties have greater motivation to participate in ACs because they require support that these groups provide. Therefore, households with higher production risks are more likely to participate in ACs since they wish to improve their farm production.

Marketing risks measure market volatility, in terms of both input and output markets. They also include risks related to competing growers, changes in consumer preferences, low product quality, loss of markets, and a failure to access market information. In this study, marketing risks directly affect participation in input and output markets and impact upon farm profitability (Aditto, 2011). Marketing risks are hypothesized to have a positive relationship with input and output markets since ACs provide their members with improved farm inputs, stable sales, and market information (Zheng et al., 2011). Therefore, the higher market uncertainty farmers face, the greater probability they will trade via ACs.

Lastly, financial risks measure the uncertainty of household income, changes in farm production costs, as well as cash flow insufficiency for farm production and household spending. In this study, financial risk indicators are risks of insufficient cash to meet expected obligations, increased input costs and interest rates, excessive borrowing, and failure to fulfil business agreements. Financial risks are hypothesized to have a positive relationship with participation in AC and AC services. Farmers who confront high financial risks tend to use AC credit services. However, financial risks have a negative relationship with loan size. While households with higher financial risks tend to borrow credit from AC, they are considered high risk borrowers. In short, loan size tends to decrease in tandem with increases in financial risks. Financial risks have a positive effect on farm input purchases from ACs since they tend to cost less and households can pay by credit (Zheng et al, 2011). Financial risks can both positively and negatively influence selling farm products through ACs. Selling via ACs can increase sellers' bargaining power but do not receive payment for their goods immediately. Thus farmers who have high levels of financial risks may prefer to sell their goods themselves to ensure immediate payment (Zheng et al, 2011).

Household perceptions of AC performances reflect their AC experiences. Households gain experience engaging with AC services and listening to other members' experiences (Hoken, 2016; Ito et al., 2012; Ma & Abdulai, 2016; Mensah et al., 2012). In our study, household perceptions of AC performance include both households and neighbours' experiences. Household perception of AC performance is measured both in terms of satisfaction (Sat) and effectiveness (Eff) of AC management (Mensah et

al., 2012). Our study also includes neighbour's attitudes to AC participation (Com_Att) and relatives as AC members (AC_Rel). These indicators are used to measure the effect of social networks on AC participation (Hoken, 2016; Ito et al., 2012; Ma & Abdulai, 2016; Mensah et al., 2012).

Expected benefits are directly related to participation in AC services since households evaluate the costs and benefits of participation before they join (Fischer & Qaim, 2012, 2014; Mensah et al., 2012). Expected benefits include advantages from participation in credit, marketing, and agricultural extension services. Credit benefit measures whether ACs assist respondents in accessing credit (CreAcc_Be) and whether ACs support borrowers in spending loans for income generating activities (IncGen_Be). Benefit of marketing services measures whether ACs support respondents to access inputs (Inp_Acc) and outputs (Out_Acc) at reasonable prices and good services. There are three benefits of participation in agricultural extension services; improvements in farm production (Prod_Be), the introduction of new technologies (Tech_Be), and access to current market information (Inf_Acc).

All factors related to household perception are self-evaluated indicators using a five-point Likert scale (except for the AC relative variable which is a dummy variable). Households were asked which scale they agreed with. The scale ranged from 1=disagree to 5= strongly agree. All variables in household perception are expected to positively influence household participation in ACs and AC services. Households choose to participate in AC services if they believe that they will obtain certain benefits.

All factors related to household perceptions (risk and AC benefit expectation variables) are assessed for validity and reliability. Validity was assessed in a pilot survey. The pilot survey result shows that the questions about household perceptions of risks and expected benefits of ACs are effective in terms of wording and the sequence of questions. The consistency and reliability of each factor are evaluated using a Cronbach's Alpha test. The results show that the Cronbach's Alpha values of all risks and AC benefit variables exceed 0.6, indicating that these variables are reliable (Hair, Black, Babin, & Anderson, 2013) (see Appendix A.1).

In this study, participation is defined in terms of the decision to participate and the level of participation. To determine the participation level in AC credit, input, and output marketing services, AC service attributes are included as explanatory variables in the participation level equation (equation 5.2) of the Heckman selection model. For credit service, credit characteristics directly determine loan size. The credit rationing theory argues that the credit market is characterised by information asymmetry, and the loan amount granted is influenced by both the borrower and lender (Zeller, 1994). In this study, credit attributes are collateral types, number of AC shares, and loan duration. These are adapted from prior studies (Atieno, 2001; Khoi et al., 2013; Menkhoff & Rungruxsirivorn, 2011). These variables are known to positively affect loan size (Khoi et al., 2013;

Ololade & Olagunju, 2013). Collateral availability has a positive impact on loan size (Fongthong & Suriya, 2014a; Menkhoff & Rungruxsirivorn, 2011; Ololade & Olagunju, 2013). Based on the AC credit rules, borrowing requires one of three types of collateral; a guarantor, assets, or AC shares. Our study asserts that providing assets or AC shares as collateral increases the size of the loan granted by ACs. The loan amount is determined by loan duration since this is correlated with risks, terms and conditions in a loan contract (Khoi et al, 2013).

Participation levels in input and output marketing services are related to their attributes (costs and benefits received from participation). Based on prior studies (Alene et al., 2008; Chagwiza et al., 2016; Mensah et al., 2012; Muthyalu, 2013; Winter-Nelson & Temu, 2005), distance to ACs negatively affects participation in AC marketing services since AC distance reflects travel costs. Moreover, the number of AC shares has positive associations with input expenditure and sale quantities via ACs marketing (Muthyalu, 2013). To capture attributes of Thai AC marketing services, purchasing method is included as an explanatory variable for the AC input marketing service model. Farm input purchase by credit indicates a benefit of AC input marketing services; therefore, purchase by credit may positively influence input expenses via ACs. For AC output marketing services, attributes include farm product price received by ACs and selling to other market channels. Output prices offered by ACs positively influence the amount of farm products sold to ACs, since high output prices motivate farmers to sell to ACs (Zheng et al., 2011). Conversely, selling to other market channels decreases the quantity of products sold to ACs.

Geographical factors help to account for differences among villages. Like Abebaw and Haile (2013), Ma and Abdulai (2016), Mojo et al. (2017), and Verhofstadt and Maertens' (2014), in this study, geographical factors are districts, distance to town, and the presence of ACs in the village. Districts are used to control for geographical difference, which directly affect agricultural production. In this study, districts are grouped into three zones following the geography; the northern districts, central districts, and southern districts. The northern districts consist of Phimai, Buayai, and Nonsong districts. The main geography of these districts is a river plain, which is suitable for agriculture. Dankhuntod district covers the central area of Nakhonratchasima. This area is suitable for agriculture as well, since it is highland. The Pakchong and Pakthongchai districts are considered southern districts, as they have mountainous geography. The district variable is a dummy variable. The Dankhuntod district is the reference dummy. The households in the southern districts are hypothesized to be negatively related to AC participation. Because of mountainous areas, it is difficult to access ACs. Households in the northern and central districts (reference dummy) may not exhibit any differences in the probability of AC participation since households in both areas work in the agricultural sector.

AC villages and distance to town are related to AC participation since they measure access to ACs and AC services. The presence of ACs in a particular village motivates households to join ACs and AC services because they can easily access facilities. However, households residing close to markets or towns are less likely to participate in ACs since they can access other credit providers and alternative marketing channels (Fischer & Qaim, 2012).

5.1.2 Estimations Diagnosis

This section reports results for model specification test to obtain consistent and efficient coefficients in the Heckman selection model. Firstly, we address the distribution of the dependent variables in the participation level equation (equation 5.2). Secondly, the Rivers and Vuong (1988) approach is applied to address the endogeneity problems in the participation equation (equation 5.1). Exclusion restrictions for the Heckman selection model are tested to obtain consistent coefficients and avoid collinearity. Finally, heteroskedasticity tests are performed to check for the consistency and robustness of the coefficients.

Dependent Variables

Loan size, farm input expenses, and sale amount used in equation (5.2) are given in logarithmic forms. Their distributions are very right-skewed (see Appendix A.2) because the three variables range from greater than zero to infinity; therefore, they are transformed into the logarithmic form. The logarithmic form of the dependent variables leads to the normal distribution of error terms in the model. In the Heckman selection model, the error terms are normally distributed. Therefore, to meet the assumption of the Heckman selection model, the dependent variables in equation (5.2) are transformed into logarithmic form. Besides, log transformation provides an economic interpretation. If log transformation is applied to both sides of the equation, the coefficient meaning indicates elasticity.

Endogeneity Problem in the Participation Equation

Our study addresses endogeneity problems in the participation equation (equation 5.1) for the AC member and AC credit model. Access to credit and agricultural extension services might be potentially endogenous variables in the participation equation for AC membership, since both variables may be jointly determined with AC participation (Abebaw & Haile, 2013; Ma & Abdulai, 2016). Similarly, regarding AC credit model, loan amount (granted by other lenders) may be an endogenous variable in AC credit participation (Khoi, 2012). To obtain consistent estimates, the endogeneity problem is treated before applying the Heckman selection model. Our study applies Rivers and Vuong's (1988) model to estimate the probit model with endogenous variables. Our study uses a member of another organization as an instrumental variable (IV). A member of another organizations is a valid IV since it strongly and significantly influences EEVs (credit accessibility and

access to agricultural extension services), however, it is not significant in terms of AC membership (see Appendix A.3.1). Similarly, being a member of other credit organizations is a valid IV for AC credit participation (see Appendix A.3.3).

The results of Rivers and Vuong model report that the estimated coefficients of the residuals for accessibility to credit and agricultural extension services are not significantly different from zero. This result indicates the absence of endogeneity problems in the participation equation of AC membership (see Appendix A.3.2). This implies that credit access and access to agricultural extension services are exogenous variables in the participation equation (AC membership). Regarding AC credit participation, the estimated results show that the coefficients of residuals for other loans is not significantly different from zero, suggesting that other loans is not an endogenous variable in the participation equation for AC credit (see Appendix A.3.4).

Exclusion Restrictions and Model Identification

The Heckman selection model requires restrictions on exclusion to obtain consistent coefficients and avoid collinearity between IMR and the regressors (Bushway, Johnson, & Slocum, 2007; Ma & Abdulai, 2016; Mojo et al., 2017; Wossen et al., 2017). Collinearity problems cause larger standard errors. This problem can be corrected using exclusion restrictions similar to an IV. Applying a valid exclusion restriction decreases multicollinearity among the explanatory variables and the correlation between error terms. This leads to model identification and efficient estimates (Bushway et al., 2007).

Exclusion restrictions require that at least one explanatory variable, which is called a selection IV, influences the decision to participation (equation 5.1) but not influence the participation level (equation 5.2). A selection IV is included in the participation equation, but excluded from the level participation equation. Our study uses household perceptions of AC performance and AC benefit expectations as a selection IV in the Heckman selection model. For the AC credit model, neighbour's attitude (Comm_Att) is used as a selection IV. We used expected benefits on input access (Inp_Acc) and output access (Out_Acc) as the selection IVs for AC input and output marketing service model, respectively. These selection IVs are valid because they satisfy the exclusion restrictions. Neighbour's attitude significantly affects a household's decisions to participate in AC credit at the 5% level but does not affect the loan size approved by ACs (see Appendix A.4). Similarly, expected benefit on input access is significant in terms of participation in AC input marketing at the 1% level (see Appendix A.5). An expected benefit on output access has significant impact on participation in AC output marketing service at the 1% level (see Appendix A.6). However, both selection IVs are not significant in terms of participation levels (farm input expenses and sale quantity through ACs).

Tests for Heteroskedasticity

Heteroskedasticity test is performed to check the consistency and robustness of the coefficients. As a result of censored data in the second stage of the Heckman selection model, the model may provide a smaller variance than the true population variance (Bushway et al., 2007). The Breusch-Pagan/Cook-Weisberg test results show that all equations have heteroskedasticity problems at the 1% level, except the model for AC input marketing services (see Appendix A.7). Therefore, to correct the standard errors, the equations are estimated using robust variance.

5.2 Results and Discussion

Our study applies the probit model (equation 5.1) to estimate household participation in ACs. Our study uses the Heckman selection model to examine the determinants that influence participation levels in three AC services; credit, input and output marketing services. The Heckman selection model for each AC service consists of the participation equation (equation 5.1) and the participation level equation (equation 5.2). The dependent variable (y_i) in the participation level equation for AC credit is loan amount. The dependent variable for AC input marketing service is input expenses through ACs, while for output marketing service it is farm product quantity sold to ACs. These systems of equations are estimated using the Heckman two-stage approach.

5.2.1 Determinants of Participation in ACs

Table 5.2 presents the probit model results. Here, the AC membership variable was regressed on household head and household characteristics, household perceptions of risk and AC performance, and geographical factors. The specification test results of the probit model for AC membership are presented at the bottom of Table 5.2. The Wald χ^2 ($\chi^2_{(29)} = 209.75$) is significant at a 99% confidence level, indicating that explanatory variables are jointly statistically significant. Furthermore, the Pseudo R-square ($R^2 = 0.417$) suggests that the model can explain a variation in AC participation. The Pseudo R-square is between 0.2 and 0.4 and represents an excellent fit (McFadden, 1977). More specifically, the model has a 82.79% prediction success, indicating that the covariates provide good estimates. The Hosmer-Lemeshow GOF test result (HL test) shows that the selected covariates fit the data well since the null hypothesis is not rejected ($\chi^2 = 6.97$ and $p=0.5396$).

Table 5.2 Determinants of Participation in AC Membership and Marginal Effects

Variables	AC Membership Participation		Variables	AC Membership Participation	
	Coefficient (Robust S.E.)	Marginal Effect (dy/dx)		Coefficient (Robust S.E.)	Marginal Effect (dy/dx)
Individual Characteristics			Household Perceptions		
Age_Yr	0.007 (0.008)	0.001	Pro_Risk	-0.576*** (0.108)	-0.126
Edu_Yr	-0.020 (0.025)	-0.004	Mkt_Risk	-0.015 (0.105)	-0.003
Sex	-0.318** (0.147)	-0.069	Fin_Risk	0.271*** (0.093)	0.059
Paddy	-0.714*** (0.241)	-0.156	Sat	0.232** (0.117)	0.051
Orchard	-0.267 (0.290)	-0.058	Eff	-0.082 (0.092)	-0.018
Cash_Crop	0.645*** (0.221)	0.141	Cre_Be	0.204*** (0.057)	0.045
Household Characteristics			Ext_Be	-0.038 (0.042)	-0.008
Inc_Pr	0.025 (0.717)	0.005	Inp_Acc	-0.076 (0.115)	-0.017
Inc_UPr	0.183 (0.287)	0.040	Out_Acc	-0.078 (0.109)	-0.017
Inc_NPr	0.310 (0.243)	0.068	Inf_Acc	0.229*** (0.077)	0.050
Farm_Mem	-0.043 (0.081)	-0.009	Geographical and related Factors		
Farm_Si	0.015** (0.007)	0.003	Dist_N	0.841*** (0.202)	0.184
Farm_Sq	-6.94e-05** (3.09e-05)	-0.00002	Dist_S	0.134 (0.219)	0.029
Land	-0.272 (0.266)	-0.059	AC_Rela	1.328*** (0.214)	0.290
Cre_Use	0.956*** (0.165)	0.209	AC_Vill	0.987*** (0.236)	0.216
Ext_Acc	0.620*** (0.162)	0.135			
Constant	-3.083*** (0.863)				
Observations		616			
Wald Chi ² ₍₂₉₎		209.75***			
Pseudo R ²		0.417			
Predicted Probability		82.79%			
Chi ² of HL		6.97			

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.

Probability of participation in ACs is significantly influenced by crop type, credit use, access to agricultural extension services, farm production risks, financial risks, household perceptions of access to credit and market information provided by ACs, AC relatives, the northern districts of Nakhonratchasima, and AC location at the 1% level (see Table 5.2). Moreover, household heads' gender, farm size, and household's satisfaction of AC management significantly influence the likelihood of participation at the 5% level (see Table 5.2). Our findings on the effect of gender are consistent with Mojo et al. (2015b, 2017) and Bernard et al.'s (2008) studies which show that females are more likely to participate in ACs than males. Moreover, crop type has a strong influence on AC participation. Cash crop farmers have 14% higher probability of participation in AC membership compared to farmers who do not grow a cash crop. This result reflects the fact that cash crops are one of major features of Nakhonratchasima. As there are many farmers growing cash crops, ACs provide facilities to support those farmers and ultimately increase their membership numbers (Zheng et al., 2011). Paddy farmers are less likely to participate in ACs. Paddy farmers usually obtain support from the Thai government. The government provides aids in the form of money and agricultural inputs. For example, the government offers a debt moratorium project and rice pledging scheme to assist farmers who face high debt and the decline in rice prices (Strategic Studies Center, 2017; Suasuwana, 2014). The government establishes the agricultural commodity bank such as organic fertilizer and rice seed banks to improve farmers' access to farm inputs (Cooperative Promotion Department, 2017). These banks enable farmers to borrow to buy fertilizers and seeds for their farm production. Further, the government provides farm production development programs to improve rice farm production. For example, the government encourages paddy farmers to use high quality seeds of jasmine rice. The government partially subsidises the organic seed expenditures. This program reduces farmers' seed cost, improves quality of yields and ultimately the increase in the rice price, which improves farmers' farm income (Thai Farmers' Library, 2019). Similarly, to resolve water scarcity for farming, the government assists farmers to access water resources with well provisions. This program encourages farmers to drill wells on their farms. Farmers who join the program pay 2,500 bahts to build a well, while the government covers the rest of the expenditure of 17,800 bahts (Land Development Department, 2019). In sum, the government has provided several programs to support paddy farmers to solve their problems including decline in rice prices, high production costs, and lack of access to water. The subsidies provided by the government cover partial expenditures of the farmers. Therefore, this encourages rice farmers to participate in the government programs rather than become AC members.

Regarding household characteristics, farm size results support the idea of the middle-class effect discussed by Bernard and Spielman (2009) and Mojo et al. (2015b). Medium-sized farmers are more likely to join ACs compared to those who have small and large farms. The probability of AC

participation increases with the number of farms that a farmer has, up to a certain level. This result indicates that mid-sized farmers obtain the benefits of ACs more than small and large sized farmers. Benefits tend to increase with household transactions via ACs (Bernard & Spielmen, 2009; Mojo et al., 2015b). Farm size positively relates to input use and production capacity (Bernard & Spielmen, 2009; Muthyalu, 2013). Small-sized farmers are less likely to participate in ACs because AC participation is less beneficial for them. Small producers use less amount of agricultural input and yield small amount of farm products. If they participate in AC marketing services, the benefits obtained from AC might be less than transaction costs (Fischer & Qaim, 2014). Therefore, the small sized farmers are less likely to become members. On the other hand, farmers with a larger farm benefit more from buying and selling products to ACs. However, AC benefits will reduce for farmers with large farms since they have greater bargaining power and gain greater benefits by selling their own products. In sum, smaller and larger farmers participate less in ACs.

Credit use increases the probability of AC participation. Farmers using credit are more likely to join ACs than non-credit users by 20.9 %. This finding indicates that farmers participate in ACs when they face liquidity constraints and need to borrow money (see Table 5.2). Similarly, access to agricultural extension services positively affects AC participation. This result implies that farmers accessing agricultural extension services tend to participate in ACs. One possible explanation is that they perform better by following ACs' standards.

In terms of household risks and perceptions of AC benefits, the results show that production risks significantly and negatively influence household participation in AC membership at the 1% level (see Table 5.2). This result suggests that the greater the farm production risk, the less likely a risky household is to participate in ACs. This result contradicts our hypothesis. This implies that production risk decreases farmer's incentives to participate in ACs; farmers may not believe that ACs are able to reduce farm production difficulties or improve their production. This is consistent with evidence that expected benefits of AC agricultural extension services do not significantly affect AC participation (see Table 5.2). In contrast, household financial risk, perceptions of credit benefits and market information have significant and positive effects on AC members at the 1% level. Similarly, AC satisfaction significantly and positively influences on AC members at the 5% level. These results suggest that farmers with higher financial risks, satisfaction with AC management, or who believe that ACs will help them access credit and market information, are more likely to join ACs as they would like to obtain loans. These findings are consistent with previous studies which show that credit access is the main reason Thai households participate in ACs (Chiengkul, 2015).

AC Relatives strongly influence household participation in ACs. Households with relatives or neighbours who are AC members have a 29% higher probability of joining ACs. This result suggests

that social network is a dominant factor influencing household decisions to participate in ACs. Living in a village which has an AC, and in the northern districts of Nakhonratchasima have positive impacts on households' decision to participate in ACs. The AC village variable reflects travel costs associated with AC membership. The probability that the households will participate in ACs is increased by 22% if they live in a village that has an AC. Furthermore, households in the northern districts (Buayai, Nonsong, and Phimai) are more likely to participate in ACs than those in the Dankhontod district (reference dummy) by 18% (see Table 5.2). This is because ACs in the northern districts have higher probability to support farmers, particularly rice farmers. ACs in the northern areas participate in rice network, which is a strong and successful network (Siamturakij Publishing Corporation, 2013). This AC cooperation succeed in improving farmers' rice production and enhancing output market accessibility.

5.2.2 AC Credit Determinants

One of the study objectives is to explore who is granted and denied AC credit. The samples used in the analysis are AC members who require credit since farmers will borrow money if they face liquidity constraints. Moreover, only AC members can apply for credit.

The Heckman selection model results show that the coefficient of IMR (λ) is not significant (see Table 5.3). This finding indicates that the error terms in the credit participation equation and the loan size equation are not related, implying the absence of a selection bias. Moreover, the Wald test for both the participation equation and loan size equation ($\chi^2 = 150.77$) rejects the null hypothesis at the 1% level; thus, the coefficients of the variables can explain the loan size granted by ACs.

Determinants of AC Credit Participation

Table 5.3 shows the Heckman selection model results of determinants of AC members' decisions to participate in AC credit services. The results show that the probability of participation in AC credit is positively influenced by farm size, distance to the nearest market, and neighbour's attitude towards AC credit participation. In contrast, it is negatively affected by household-head education and farm asset ownership. The findings show that household-head education is negatively significant in terms of a household's decision to borrow from ACs at the 5% level, indicating that household-heads with higher educational attainment are less likely to borrow money from ACs. The result is consistent with Fongthong and Suriya (2014), Khoi et al. (2013), Sebopetji and Belete (2009), Duy et al. (2012), and Zeller's (1994) findings, which suggest that less-educated individuals are more likely to borrow from informal credit sources.

Effects of farm asset ownership and farm size suggest that ACs are the important credit sources for poor households, consistent with Tetteh Anang et al. (2015) and Nguyen's (2007) findings. Farm

asset ownership has a negative significant relationship with AC credit participation at the 5% level. Our results show that households who have less farm capital have a higher probability of accessing AC credit than those who have farm capital (by 4.6%) (see Table 5.3). This figure implies that ACs are the main credit source for poor farmers who cannot access formal loans. Household capital endowments are important factors for accessing formal credit (Tetteh Anang et al., 2015). Farmers who hold small endowments are evaluated by lenders as being poor and not creditworthy; thus, poor farmers are less likely to access loans from formal lenders (Tetteh Anang et al., 2015). They are, however, able to access credit from ACs since they can use co-guarantors instead of collateral.

Table 5.3 Determinants of AC Credit Participation using the Heckman Two-Step Method

AC Credit Participation			AC Loan Size (Log)		
Variables	Coefficient (Robust S.E.)	Marginal Effect	Variables	Coefficient (Robust S.E.)	% Change in Y
Individual Characteristics					
Age_Yr	-0.013 (0.010)	-0.001	lgAge	0.219 (0.246)	
Edu_Yr	-0.059** (0.029)	-0.006	lgEdu	0.210* (0.110)	
Paddy			Paddy	0.041 (0.107)	4.13
Orchard			Orchard	0.105 (0.192)	11.07
Cash_Crop			Cash_Crop	0.266** (0.116)	27.25
Household Characteristics					
Farm_Mem	0.044 (0.119)	0.0046	lgFarm_Mem	0.056 (0.100)	
Farm_Si	0.018** (0.008)	0.0018	lgFarm_Size	0.156*** (0.052)	
Farm_Sq	-9.66e-05** (3.92e-05)	-0.00001			
Farm_Ass	-0.487** (0.229)	-0.0455			
Oth_loan	-4.86e-07 (4.07e-07)	-5.07e-08			
Ext_Acc	0.443* (0.232)	0.0579			
Household Perceptions					
Pro_Risk	-0.010 (0.129)	-0.0009	Pro_Risk	-0.018 (0.050)	-1.76
Mkt_Risk	0.096 (0.146)	0.010	Mkt_Risk	-0.045 (0.054)	-4.38
Fin_Risk	-0.056 (0.110)	-0.05886	Fin_Risk	-0.095** (0.044)	-7.35
CreAcc_Be	-0.147 (0.141)	-0.0153			
IncGen_Be	0.139 (0.109)	0.01447			
AC Credit Attributes					
			lgAC_Share	0.143*** (0.032)	
			ACdur_Med	0.643*** (0.181)	79.68
			ACdur_Long	0.699*** (0.190)	100.57
			Coll_Prop	0.401*** (0.087)	43.76

Table 5.3 Determinants of AC Credit Participation using the Heckman Two-Step Method (cont.)

<i>AC Credit Participation</i>			<i>AC Loan Size (Log)</i>		
Variables	Coefficient (Robust S.E.)	Marginal Effect	Variables	Coefficient (Robust S.E.)	% Change in Y
<i>Geographical Factors</i>					
Dis_Town	0.041*** (0.012)	0.004			
Dist_N	-0.180 (0.241)	-0.019	Dist_N	0.423*** (0.114)	54.50
Dist_S	0.354 (0.303)	0.033	Dist_S	0.336*** (0.112)	40.64
Comm_Att (IV)	0.163** (0.073)	0.017			
Constant	1.128 (1.059)			8.132*** (1.090)	
Lambda			-0.479		
Rho			-0.619		
Sigma			0.774		
Observation			461		
Wald chi ²			150.77***		

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.

Comm_Att is used as a selection IV for this model.

Although ACs offer credit to poor households, borrowers must show that they are able to repay their loans. The findings are confirmed by the effect of farm size. The probability of participating in AC credit increases with greater farm size but decreases at a certain level. Farmers who have small farms cannot access AC credit due to their inability to repay their loans. Farmers who have larger farms will not borrow loans from ACs since they can access formal loans with lower interest rates, such as BAAC loans. Middle-class farmers are more likely to borrow loans from ACs rather than those with small or large farms. However, the magnitude effect of farm size is very small. The probability of access to AC credit increases by 0.18% for each additional rai of farm (see Table 5.3).

Furthermore, distance to town significantly and positively influences the probability of AC credit participation at the 1% level, indicating that households are more likely to participate in AC credit when they live far from town. Households living far from town face difficulties in accessing formal credit facilities. In addition, a neighbour's attitude to AC participation has a significant and positive association with AC credit participation at the 5% level. This result suggests that households who obtain information about ACs from neighbours tend to borrow credit from ACs. This finding shows the role of social capital in sharing AC information to potential participants.

Determinants of AC Loan Size

Regarding loan size, the second step of the Heckman selection model results confirm that loan size is significantly determined by household characteristics, AC credit attributes, and geographical factors

(see Table 5.3). Cash crop farming has a significant and positive influence on loan size granted by ACs at the 5% level, indicating that farmers growing cash crops borrow bigger amounts of loans than those who do not grow cash crops (27.25%). Furthermore, loan amounts significantly increase with farm size at the 1% level, consistent with Duong and Izumida (2002), Coleman (2006), Khoi et al. (2013), Nguyen (2007), and Duy et al.'s (2012) findings. If farm size increases by 1% percent, loan size will increase by 15.6%. Farmers with larger farm need more financial capital to invest in production. Therefore farmers with larger farms will borrow larger loans compared to those with smaller farms.

In terms of farm risks, loan size is significantly affected by financial risk at the 5% level. This finding suggests that loan sizes are lower for farmers who confront higher financial risks. A 1% increase in financial risk will likely decrease the loan size approved by ACs (by 7.35%) (see Table 5.3). However, farm production and market risks do not impact upon AC loan size.

Interestingly, the findings show that AC credit attributes strongly dominate loan size at the 1% level. AC share, loan duration, and using property as collateral have positive effects on loan size. Besides co-guaranteed collateral, AC shares and property are used as collateral to borrow loans from ACs. Therefore, the more AC shares and property members use as collateral, the greater the loan size borrowers receive. Loan duration has a great impact on AC loan amount; larger loan amounts are equated with longer loan repayment periods. The result shows that households borrowing intermediate or long term loans will receive a greater loan amount than those borrowing short-term loans by 79.68% and 100.57%, respectively. This is in line with Khoi et al.'s (2013) study, where the size of informal credit was found to have a positive relationship with an increase in loan duration.

Regarding location, the findings show that district are significantly correlated to loan amount at the 1% level. ACs in different districts provide different loan amounts for their members. Households in the northern and southern districts of Nakhonratchasima receive greater loan amounts than those borrowing from the Dankhuntod AC (reference ACs). This finding relates to limited financial capital which varies between ACs. Thus different ACs will provide different loan amounts.

5.2.3 Determinants of Input Marketing Services

Our study investigates AC members' decisions to purchase farm inputs through ACs. The samples include only AC members, since only households who are members can purchase farm inputs through them. Participation in AC input marketing services is defined in terms of the decision to participate and the purchase of various inputs. In our study, input use is measured by input expenditure. Input expenses include the cost of seeds, saplings, fertilizer, and pesticides.

To address the selection bias, we use the Heckman model to estimate the determinants of participation in AC input marketing services. Table 5.4 presents the determinants of household

participation in AC input marketing services and the determinants of farm input expenditures. The Wald test for the participation equation and the input expenditure equation ($\chi^2 = 130.59$) rejects the null hypothesis at the 1% level; thus, the coefficients of the variables can explain input expenses. The coefficient of IMR (λ) is not significant, indicating that error terms in the participation equation and the input expense equation are not related. This implies the absence of a selection bias.

Determinants of Participation in AC Input Marketing Services

The findings show that members' decisions to purchase farm inputs through ACs are significantly influenced by farm size, perceived benefits, and district at the 1% level. Cash crop farming, technology accessibility, and residing in villages with ACs is significant at the 5% level (see Table 5.4).

As expected, the effect of farm size on participation in AC input marketing services is positively significant, a finding consistent with previous studies (Ma & Abdulai, 2016; Muthyalu 2013). Farm size relates to household wealth and farm production scale. An increase in farm size by one rai raises AC members' probabilities of joining AC input marketing services by 0.7%. However, this will decline when farm size reaches a certain level. This findings confirm the middle-class effect; mid-sized farmers have the greatest probability of accessing AC marketing services (Fischer & Qaim, 2012).

Further, the probability of purchasing farm inputs from ACs significantly increases with household attitude; this relates to whether ACs help farmers to access input markets or not. If farmers are in a stronger position, believe that ACs will assist them to access materials of good quality at reasonable prices and support them with purchasing modern inputs, they have a 6.8% greater probability of buying farm inputs from ACs. This result indicates that experience and information received play vital roles in a household's decision to participate in AC services.

AC location is an important factor which impacts on household participation in input marketing services. AC members in the Dankhantod district, a based dummy variable, are more likely to purchase inputs through ACs than those in northern (Phimai, Buayai, Nonsong districts) and southern districts (Pakchong and Pakthongchai districts) by 32.1% and 20.8%, respectively.

Regarding significant factors at the 5% level, participation in AC input marketing services declines with cash crop farming. Cash crop farmers have a 17.2% less likelihood to access AC input marketing service than other farmers (see Table 5.4). On the other hand, farmers accessing farm technologies and residing in an AC village have 17.9% and 14.5% higher likelihoods of purchasing farm inputs from ACs, respectively. ACs provide advanced technologies and inputs to households for farm production improvement. In short, households can access new technologies by purchasing them through ACs. Residing in a village with an AC reflects the distance to ACs and travel costs. Since distance to ACs incurs transaction costs, it reduces farm returns (Winter-Nelson & Temu, 2005). Therefore,

households living in the same village with ACs tend to buy farm input from them. The result is consistent with prior studies (Ma & Abdulai, 2016; Muthyalu, 2013). This finding may explain why farmers living close to ACs have better access to them and are more likely to use their services. In contrast, farmers who face greater difficulties accessing ACs may expect less benefits from them and thus are less likely to participate.

Determinants of AC Farm Input Expenditure

AC input expenditure is influenced by farm size, farm income, production risk, and payment method (see Table 5.4). As expected, farm size and farm income have significantly positive effects on AC input expenditure at the 1% level. If farm size increases by 1%, farmers are more likely spend more buying inputs from AC (46.2%) (see Table 5.4). This result is in line with results presented by Muthyalu (2013) who find that a proportionate change in farm size will likely increase levels of AC input and output marketing services. Similarly, the positive coefficient of farm income suggests that richer households tend to purchase higher input amounts. The coefficient of farm income is consistent with Winter-Nelson and Temu's (2005) study.

Farm production risk has a significant and negative effect on AC Input use, while payment method has a significant and positive effect at the 5% level. AC members spend 13.84% less on farm inputs if they have higher farm production risks. Besides, the percentage of input expenses increases dramatically with input purchasing on credit. Farmers who buy inputs from ACs on credit tend to spend more than those who do not use credit (by 31.65%). Survey evidence shows that 71% of members purchase farm inputs from ACs because they can buy using credit. This finding reflects the important role of trade credit in supporting farmers' access to farm inputs.

5.2.4 Determinants of Output Marketing Services

Our study analyses members' decisions to sell farm products through ACs. The samples used in the analysis exclude AC members whose farms are self-sufficient since these samples do not need to select a market channel to sell their farm products. Our study considers participation decision and sale quantity. To account for the selection bias, determinants of output marketing participation are estimated using the Heckman selection model.

The Wald test for the participation equation and the sale quantity equation ($\chi^2 = 158.01$) rejects the null hypothesis at the 1% level (see Table 5.5). This suggests that the coefficients of these variables can explain the farm product quantity sold to AC. The coefficient of IMR (λ) is not significant. This result indicates that error terms in the participation equation and the sale quantity equation are not related, implying the absence of a selection bias.

Table 5.4 Determinants of AC Input Marketing Participation using the Heckman Two-Step Method

AC Input Marketing Participation			AC Input Expense (Log)		
Variables	Coeff (Robust S.E.)	Marginal Effect	Variables	Coeff (Robust S.E.)	% Change in Y
<i>Individual Characteristics</i>					
Age_Yr	0.003 (0.007)	0.001	lgAge	-0.174 (0.287)	
Edu_Yr	0.033 (0.020)	0.013			
Paddy	-0.111 (0.178)	-0.044			
Cash_Crop	-0.445** (0.189)	-0.172			
Orchard	-0.455 (0.306)	-0.165			
<i>Household Characteristics</i>					
Farm_Si	0.017*** (0.005)	0.007	lgFarm_Size	0.462*** (0.132)	
Farm_Sq	-5.68e-05** (2.64e-05)	-0.00002			
Farm_Mem	-0.030 (0.070)	-0.012	lgFarm_Mem	0.051 (0.151)	
Farm_Inc	-1.18e-07 (1.30e-07)	-4.59e-08	lgFarm_Inc	0.211*** (0.078)	
Irr_Acc	-0.292 (0.199)	-0.113			
Tech_Acc	0.462** (0.197)	0.179			
<i>Household Perceptions</i>					
Pro_Risk	-0.041 (0.081)	-0.016	Pro_Risk	-0.149** (0.073)	-13.84
Mkt_Risk	0.080 (0.086)	0.031	Mkt_Risk	0.110 (0.075)	11.63
Fin_Risk	-0.09 (0.072)	-0.036	Fin_Risk	0.001 (0.064)	0.14
Inp_Acc (IV)	0.175*** (0.066)	0.068	Inp_Acc		
<i>AC Attributes</i>					
			lgAC_Share	0.069 (0.042)	
			ACInp_Cre	0.275** (0.132)	31.65
			ACdis	0.008 (0.006)	0.81
<i>Geographical and Related Factors</i>					
Dist_N	-0.851*** (0.190)	-0.321	Dist_N	-0.137 (0.192)	-12.80
Dist_S	-0.557*** (0.182)	-0.208	Dist_S	0.246 (0.161)	27.89

Table 5.4 Determinants of AC Input Marketing Participation using the Heckman Two-Step Method (cont.)

AC Input Marketing Participation			AC Input Expense (Log)		
Variables	Coefficient (Robust S.E.)	Marginal Effect	Variables	Coefficient (Robust S.E.)	% Change in Y
AC_Vill	0.368** (0.173)	0.145			
Comm_Att	0.085* (0.044)	0.033			
Constant	-0.966 (0.660)			5.522*** (1.276)	
lambda				-0.120	
Rho				-0.150	
Sigma				0.805	
Observation				503	
Wald chi ²				130.59***	

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.

Inp_Acc is used as a selection IV for this model.

Determinants of Participation in AC Output Marketing Services

Our study suggests that the decision to sell farm products to ACs is positively influenced by paddy farm, farm size, AC benefits related to output market accessibility, and the southern districts. It is negatively affected by financial risk and distance to ACs. The positive relationship between rice farming and the probability of selling products to ACs suggests that rice farmers are more likely to participate in AC output marketing services than farmers who do not grow rice (by 10.6%) since rice network among ACs is successful in rice market enhancement (Siamturakij Publishing Corporation, 2013) (see Table 5.5).

The effect of farm size on the probability of participating in AC output marketing services reflects the middle-class effect. This result is consistent with Fischer and Qaim (2012, 2014), Mensah et al. (2012), and Zhang et al.'s (2017) findings. Farm size is positive and significantly impacts upon participation in AC output marketing services at the 5% level. If the household farm size increases by one rai, the household will have a 0.4% higher probability of participating in AC output marketing services. This effect will decline at a certain level of farm size. This result confirms that mid-sized farmers have the greatest probability of accessing AC output marketing services (Fischer & Qaim, 2012). Farmers who hold less farmland may not prefer to sell to ACs due to high transaction costs. Big farm farmers who produce large quantities of farm products gain greater benefits from selling their products individually since they have higher bargaining power.

Table 5.5 Determinants of AC Output Marketing Participation using the Heckman Two-Step Method

Participation in AC Output Marketing			AC Sale Amount (Log)		
Variables	Coefficient (Robust S.E.)	Marginal Effect	Variables	Coefficient (Robust S.E.)	% Change in Y
Individual Characteristics					
Age_Yr	0.006 (0.008)	0.001	lgAge	-0.036 (0.664)	
Edu_Yr	0.022 (0.025)	0.006	lgEdu	0.172 (0.267)	
Paddy	0.456** (0.224)	0.106	Paddy	-0.227 (0.323)	-20.31
Cash_Crop	0.166 (0.245)	0.042	Cash_Crop	-0.180 (0.366)	-16.47
Orchard	0.227 (0.346)	0.063	Orchard	-1.324*** (0.411)	-73.39
Household Characteristics					
Farm_Mem	0.103 (0.086)	0.026			
Farm_Si	0.017** (0.006)	0.004	lgFarm_Size	0.825*** (0.140)	
Farm_Sq	-7.04e-05** (3.54e-05)	-0.00002			
Commer	-0.443 (0.426)	-0.112	Commer	1.924*** (0.712)	584.83
Cre_Use	0.360 (0.233)	0.079			
FarInc_PU	-0.010 (0.215)	-0.003			
Household Perceptions					
Pro_Risk	-0.063 (0.096)	-0.016	Pro_Risk	-0.079 (0.119)	-7.60
Mkt_Risk	-0.095 (0.105)	-0.024	Mkt_Risk	-0.177 (0.139)	-16.22
Fin_Risk	-0.189** (0.089)	-0.048	Fin_Risk	0.122 (0.117)	12.98
Out_Acc (IV)	0.366*** (0.092)	0.093			
Inf_Acc	-0.016 (0.069)	-0.004			
AC Attributes					
			lgAC_Share	0.076 (0.071)	
			AC_P	-0.164*** (0.051)	
			ACpay_n	0.183 (0.304)	
			ACothsale	-0.427** (0.194)	

Table 5.5 Determinants of AC Output Marketing Participation using the Heckman Two-Step Method (cont.)

Participation in AC Output Marketing			AC Sale Amount (Log)		
Variables	Coefficient (Robust S.E.)	Marginal Effect	Variables	Coefficient (Robust S.E.)	% Change in Y
Geographical Factors					
Dist_N	0.047 (0.230)	0.012	Dist_N	0.426 (0.378)	53.11
Dist_S	0.760*** (0.224)	0.216	Dist_S	0.399 (0.396)	49.03
ACdis_n	-0.018** (0.007)	-0.005			
Constant	-2.780*** (0.969)			5.366* (3.176)	
Lambda				0.092	
Rho				0.106	
Sigma				0.869	
Observation				460	
Wald chi ²				158.01***	

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.

Out_Acc is used as a selection IV for this model.

Household perceptions of access to output market has the strongest impact on a household's decisions to sell its products through AC channels. Farmers selling their products to ACs believe that they will receive higher sale prices, compared to non-participants. In contrast, the financial risk is significant and has a negative impact on selling farm products to ACs at the 5% level. This result suggests that households with higher financial risks have a 4.8% less probability of participating in AC output markets (see Table 5.5). This result is expected because farmers who have liquidity constraints want to receive money instantly; if they sell their products to ACs they will not receive payment until a later date.

In terms of geographical factors, the results indicate that members of ACs who live close to ACs in the south of Nakhonratchasima (Pakchong and Pakthongchai AC) are more likely to sell their products to ACs. Districts in the South of Nakhonratchasima are positive and statistically significant at the 1% level while AC distance is significant and negative at the 5% level. This finding is consistent with prior studies (Chagwiza et al., 2016; Muthyalu, 2013). The probability of participation in AC output marketing services decreases with distance from farm to ACs because of transaction costs. The further away the farmers live, the greater the transaction costs they incur and the less profit they make.

Determinants of AC Sale Quantity

AC farm product quantity is determined by orchard farm, farm size, ratio of sale to yields (Commer), output price offered by ACs, and selling through alternative channels (see Table 5.5). The findings show that orchard farming has a significantly negative effect on sale amount to ACs at the 1% level. This implies that the amount of farm products sold to ACs is less for orchard farmers since ACs in the study do not buy vegetables and fruits from members.

Farm size and the portion of sales are positive and significantly impact the sale amount through ACs at the 1% level. If farm size increases by 1%, participants in AC output marketing services will sell more outputs to ACs (82.5%). Similarly, if the ratio of sale on yields increases by 1%, farm sales to ACs increase 5 times (584.83%). These results support the view that the more households trade through ACs, the greater the benefits they gain (Fischer & Qaim, 2014).

Interestingly, the level of marketing participation depends on AC service attributes. The percentage of sales to ACs significantly decreases with selling to other channels and output prices offered by ACs at the 5% and 1% level, respectively. Farmers selling their product to both ACs and other channels sell less products (quantity wise) to ACs compared to farmers who sell only to ACs. The effect of selling to other channels implies that when farmers have many market channels, they tend to sell less products to ACs. This finding suggests that ACs are not their first choice. The relationship between the quantity of products sold to ACs and the price received from ACs is negative. When the price of a farm product increases in the market, ACs have to offer higher prices to induce members to sell their products to them. However, most Thai ACs are small and their funds are limited, thus they are unable to purchase all of their members' farm products (Thuvachote, 2007). When faced with higher output prices, ACs, which have limited financial resources, purchase less farm products.

5.2.5 Determinants of Participation in AC Agricultural Extension Services

Table 5.6 presents the estimated results of participating in AC agricultural extension services, which are regressed on individual and household characteristics, household perceptions of risk, AC performance, and geographical factors. The specification test results show that the model for participation in AC agricultural extension services fits the data well. The Wald χ^2 ($\chi^2_{(18)} = 88.01$) is statistically significant at a 99% confidence level, indicating that the explanatory variables are jointly statistically significant. Moreover, the Pseudo R-square ($R^2 = 0.1929$) indicates that the covariates in the model provide good estimates. The model exhibits 80% success in correct prediction. The Hosmer-Lemeshow test result indicates that the null hypothesis is not rejected ($\chi^2_{(8)} = 0.862$), suggesting that the selected covariates fit the data well.

The estimated results of the probit model show that participation in AC agricultural extension services is related to household characteristics (land ownership, irrigation accessibility and off-farm work), household perceptions of production risk and AC satisfaction, the district, and whether the village has an AC. The coefficient of land ownership is positive and significant at the 5% level, indicating that land-holding households are more likely to participate in AC agricultural extension services (8.4% more) than landless households (see Table 5.6). This finding is expected because farmers holding land gain benefits from adopting technologies and farm practices offered through agricultural extension services. This finding is consistent with previous studies (Atsan et al., 2009; Elias et al., 2013).

In addition to land ownership, paid employment outside the farm is significant and positively influences the probability of joining AC agricultural extension services at the 5% level. This finding is consistent with Ma's (2016) work. Households who have employment elsewhere are more likely to participate in such services since off-farm work increases household income. Increased income enables households to buy equipment, apply for updated farm technologies or practices offered through agricultural extension services.

However, access to irrigation has a significantly negative effect on participation in AC agricultural extension services at the 1% level. Farmers who access irrigation systems are 9.2% less likely to participate in these services than non-irrigation users. Farm production efficiency depends on access to irrigation. Farmers with irrigation systems are in a good position in terms of farm production; thus, they may be not interested in farm improvements when compared with farms that have no irrigation. This finding contradicts Egziabher et al.'s (2011) work. They find that access to irrigation does not have a significant impact on participation in agricultural extension services in Ethiopia.

Based on the household perceptions of agricultural risk and AC performance, the findings show that household production risk and AC satisfaction are positive and significantly impact on participation in AC agricultural extension services at the 1% and 5% level, respectively. These results indicate that households with higher production risks and satisfaction with AC performance are more likely to participate in agricultural extension services. This finding suggests that household experiences of AC operations are important factors in a household's decision to join agricultural extension services.

In terms of geographical factors, residing in a village with an AC is significant and positively increases the probability of using the services at the 5% level. This outcome is consistent with previous studies (Egziabher et al., 2011). Households living close to ACs find it easier to access farm support services and have lower travel costs than those living further away. Moreover, farmers living in the northern districts have a 9.3% lower probability of joining AC agricultural extension services than those living in the Dankhuntod district (see Table 5.6). This is because the northern districts have less farmers

who are interested in using improved technologies and farm practices in their production (79.77%) than those in Dankhuntod district (82.48%).

Table 5.6 Determinants of Participation in AC Agricultural Extension Services and Marginal Effects

AC Agricultural Extension Services					
Variables	Coefficient (Robust S.E.)	Marginal Effect	Variables	Coefficient (Robust S.E.)	Marginal Effect
Individual Characteristics			Household Perceptions		
Age_Yr	-0.0002 (0.008)	-0.00004	Pro_Risk	0.382*** (0.096)	0.069
Edu_Yr	-0.02 (0.021)	-0.004	Sat	0.232** (0.106)	0.042
Sex	-0.271* (0.163)	-0.049	Eff	-0.066 (0.085)	-0.012
Household Characteristics			Prod_Be	0.022 (0.070)	0.004
Farm_Mem	0.149* (0.083)	0.027	Tech_Be	-0.124 (0.079)	-0.023
Farm_Si	-0.0009 (0.002)	-0.0002	Inf_Acc	0.223*** (0.066)	0.040
Land	0.463** (0.216)	0.084	Geographical Factors		
Irr_Acc	-0.509*** (0.155)	-0.092	Dist_N	-0.514** (0.204)	-0.093
Off_Farm	0.399** (0.163)	0.072	Dist_S	0.015 (0.225)	0.003
Cre_use	0.328* (0.197)	0.060	AC_Vill	0.483** (0.227)	0.088
Constant	-1.765** (0.743)				
Observations		528			
Wald $\chi^2_{(18)}$		88.01***			
Pseudo R ²		0.1929			
Predicted Probability		79.92%			
Chi ² of HL		0.862			

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.

5.3 Chapter Summary

Our study investigates the determinants of household participation in AC and AC services; credit and non-credit support services in Thailand. To address the selection bias, our study has applied the Heckman selection model. The estimated results indicate that ACs play a significant role in assisting middle-class households to access credit facilities and markets where they can sell their produce. Farm risks, and perceptions of benefits obtained from AC services, have significant effects on a household's decision to participate in AC services. Moreover, AC service attributes significantly determine AC service participation levels.

Our findings confirm that the decision to become a AC member is strongly influenced (at the 1% level) by the following factors; crop type, credit use, access to agricultural extension services, farm production risk, financial risk, household perceptions of access to credit and market information provided by ACs, AC relatives, the northern districts of Nakhonratchasima, and AC location (proximity to the farmer). These statistical factors suggest that social networks and location play a significant role in motivating households to join ACs. Households who have relatives or neighbours who are AC members receive information about AC performance and benefits; thus, they are more likely to participate in ACs. This finding implies that current AC members are important resources as they share AC information with potential customers. In addition, households residing in an AC village and in northern districts are more likely to be AC members; the presence of an AC in a village means that households have easy access. Moreover, the results indicate that AC members often confront liquidity constraints and have high expectations that ACs can support them in obtaining credit. Middle-class farmers who face low production risks and can access agricultural extension services are more likely to join ACs. In sum, households decide to participate in ACs because they need credit.

Determinants which influence AC credit participation include education, farm size, farm asset ownership, access to agricultural extension services, distance to the nearest market, and neighbours' attitudes to ACs. ACs play a significant role in the rural credit market since they function as complimentary credit lenders for households who are unable able to borrow from formal institutions. The findings indicate that households who do not own farm assets are more likely to borrow money from ACs. These farmers cannot access formal credit due to low asset ownership. However, they can borrow money from ACs, since other members act as guarantors. The results show that households who participate in AC credit services are overwhelmingly middle-class, indicating that the lower-tier poor still confront difficulties accessing credit. In terms of participation levels, loan amounts are significantly determined by AC credit attributes such as AC shares, loan duration, and property as collateral. Households who have higher AC share values and provide property as collateral are more likely to obtain larger loans.

Members' decisions to use marketing services are significantly influenced by a household's perception of the benefits that will be gained from their participation, as well as farm size and geographical factors. Households who use marketing services believe that ACs can assist them to acquire quality inputs at reasonable prices and provide them with reasonable prices for farm products. Mid-sized farmers have the greatest access to AC marketing services since the probability of AC marketing participation increases with farm size but decreases with farm size squared. Moreover, the decision to trade via ACs is associated with travel costs. Participation in input marketing services is positively related to living in an AC village, meaning that farmers who live in an AC village are more likely to buy farm inputs from them due to lower travel costs. In contrast, AC output marketing participation is negatively influenced by distance to ACs. Regarding participation levels in AC marketing services, input expenditure and product quantity sold through ACs is determined by household characteristics such as farm size, family income, and AC marketing attributes (such as buying inputs on credit and AC output prices).

Lastly, a household's decision to participate in AC agricultural extension services are significantly determined by its characteristics, perception of ACs and location. Households which own land and work in off-farm activities have a higher probability of joining AC agricultural extension services. These households earn additional income which means that they can afford new technologies; in turn, they benefit financially from the adoption of such technologies. In contrast, farmers who have access to irrigation systems are less likely to join AC agricultural extension services since they have less incentives to improve their production. In terms of household perceptions, households with higher production risks and satisfaction tend to participate in AC agricultural extension services because they believe that ACs can increase their efficiency. The presence of ACs in a village motivates households to join agricultural extension services because of easy accessibility.

The results show that AC credit and marketing services play an important role in assisting the middle-class households. This finding indicates that the poor still face credit access constraints, even in terms of ACs. To improve AC participation rates, especially for the very poor, ACs should provide training services. High production risk is a significant obstacle for farmers wanting to join ACs. In addition, households who access AC credit facilities tend to have higher financial risks. To reduce production and financial risks, ACs should extend training services, both in agricultural and off-farm activities, to develop members' skills. Courses could include on-farm product processing to add value to members' products and ones which focus on income generation. These skills are essential to increase farmers' capabilities in mitigating farm risk and increase their AC participation opportunities.

The results also show that distance to ACs is significant in terms of member participation. ACs should consider reducing farmers' transaction costs as this would encourage members to use their

marketing services. Household participation in AC marketing services decreases in tandem with distance. Developing an AC network may reduce transportation costs and increase the group's bargaining power. Both vertical and horizontal networks should be promoted. A vertical network, with other stakeholders in the supply chain, may reduce transportation costs for AC members. For example, contracts with input wholesalers would potentially lead to lower input prices and transportation costs. Since wholesalers may have several distributors in the cities, AC members should be able to pick up inputs from the closest distributor. Likewise, a horizontal network would reduce production costs and increase bargaining power.

Chapter 6

Effects of Agricultural Cooperative Services on Household Welfare

This chapter evaluates the effects of participation in AC credit and non-credit support services on rural household economic and social welfare. To address the selection bias arising from observed and unobserved factors, this study employs ESR and ESP models to assess household welfare using survey data. This chapter is organized as follows. Section 6.1 presents the empirical models used to evaluate the AC effect. Section 6.2 provides the results of exclusion restriction test. Section 6.3 discusses the effects of participation in AC credit and non-credit support services on both household economic and social welfare. Section 6.4 summarizes the empirical findings.

6.1 Empirical Model

This chapter evaluates the effects of AC service participation on participants (a treated group) and non-participants (an untreated or control group). AC services include credit, marketing services, and agricultural extension services. This study employs 2017 survey data. For AC credit, the treated group includes households who borrowed money from ACs in the year 2015 (458 respondents), while, the control group covers households who did not use AC credit services in the same year (393 respondents). This study considers effects on household economic and social welfare for the year 2016 including household and farm income, consumption, educational expenditure, and health access. If households borrowed money from ACs in 2015, they will invest their loans in income generating activities. The yields of investment may not be evident until the following year (2016), therefore, we concentrate on AC loans established in the year 2015.

The treated and control groups in AC marketing services and agricultural extension services are defined in similar ways. If households participated in non-credit support services in the year 2016, they will be included in the treated group (273 respondents for the AC marketing service model and 474 respondents for the AC agricultural extension service model), otherwise they are included in the control group (578 respondents for the AC marketing service model and 377 respondents for the AC agricultural extension service model). For AC marketing and agricultural extension services, the study considers the effects of participation in non-credit support services which happen in the year 2016. If households traded individually or via ACs in 2016, they will receive farm income in 2016.

Households self-select to participate in AC services; thus, unobservable characteristics (that is, households' farm abilities and risk preferences) are likely to correlate with households' decisions to participate in AC services and their welfare, such as household and farm income, and consumption (Ma, 2016; Mojo et al., 2017; Verhofstadt & Maertens, 2014). To mitigate the selection bias arising

from observed and unobserved factors, this study applies two models (the ESR and ESP models) to evaluate effects of AC service participation on a household economic and social welfare.

This study considers two AC services: AC credit and non-credit support services, along with eight outcome indicators: household income, farm income³, household consumption, educational expenditure for children in the family, health affordability, school enrolment, adoption of improved farm technologies and practices, and health access improvement. While the first five indicators are continuous variables, the last three indicators are binary variables. The ESR model is applied to evaluate the effects of AC service participation on continuous outcome variables (the first five indicators), while the ESP model is used to assess the effects of AC service participation on binary outcome variables (the last three indicators). Therefore, this study consists of five ESR models for AC credit, five ESR models for non-credit support services, three ESP models for AC credit, and three ESP models for non-credit support services.

The ESR model consists of two stages: the participation stage and the outcome stage. In the first stage, households decide whether to participate in AC services or not. This study uses the probit model (equation 6.1) to determine the probability of a household's decision to participate in AC services. The second stage specifies the outcome equations for AC service participants (equation 6.2) and non-participants (equation 6.3). The ESR model is presented as:

$$D_i^* = \delta z_i + \varepsilon_i$$

$$D_i = \begin{cases} = 1, & \text{if } D_i^* > 0 \\ = 0, & \text{if otherwise} \end{cases} \quad (6.1)$$

$$\text{Regime 1:} \quad y_{iP} = \beta_{iP}x_i + \mu_{iP} \quad \text{if } D_i = 1 \quad (6.2)$$

$$\text{Regime 2:} \quad y_{iN} = \beta_{iN}x_i + \mu_{iN} \quad \text{if } D_i = 0 \quad (6.3)$$

Where D is AC service participation; $D_i=1$ if households decide to participate in AC services, and 0 otherwise. y_{iP} and y_{iN} are continuous outcome indicators for AC service participants and non-participants, respectively; Z_i and X_i denote explanatory variables influencing a household's decision to participate in AC services and household outcomes, respectively. Explanatory variables are individual characteristics (that is, age, education, crop type), household characteristics (such as number of household members, farm size, farm assets, landownership, credit use, and access to agricultural extension services), a household's perceptions of risk (farm production, financial, and market risks),

³ Annual farm income is calculated as the value of crop and livestock production, excluding non-marketed produce valued at market prices.

geographic and other related factors (that is, district, relatives in ACs, and ACs in village). ε_i , μ_{iP} , and μ_{iN} are the error terms in participation equation, outcome equation for participants, and outcome equation for non-participants. The error terms are assumed to have a normal distribution with a zero mean.

The outcome indicators in the ESR model are in logarithm. The distribution of the outcome variables in the ESR model is right skewed since income and expenditures range from zero to infinity (see Appendix B.1). Transforming outcome variables into the logarithmic form provides many advantages for estimation. Firstly, the logarithmic form can reduce the effects of potential influential observations (Verhofstadt & Maertens, 2014). If data distribution has a right or left skew and there are some outliers in dependent or independent variables, a log transformation can decrease the influence of outlier observations. Moreover, the logarithmic form converts the error distribution in the model close to normal so that it is closer to normal distribution. To obtain consistent estimates, the ESR model requires that the distribution of error terms is normal. Therefore, a log transformation leads to normal distribution of error term and yields consistent estimates. It also benefits economic interpretation of the results, which can be directly interpreted in percentage terms.

A log transformation with outcome indicators leads to problems for impact assessment when some outcomes equal zero. Selected households in the sample have no farm income and no affordability to access medical treatment. A log transformation will drop these households since log zero is undefined. This means that respondents with zero outcomes are excluded from the effect evaluation. Inverse hyperbolic sine transformation (IHS) can solve the problem of non-positive values without distorting the standard error (Pence, 2006). The IHS is more appropriate than a log transformation since it provides a way to estimate effects without dropping non-positive outcome samples. Moreover, the value of IHS transformation equals the logarithmic value. The IHS has been used in many studies. For example, Pence (2006) investigates the effects of tax incentives on wealth. Chandra (2003) and Johnson, Kitamura, and Neal (2000) study the impact of the black-white gap on wages.

The system of equations (equations 6.1, 6.2, and 6.3) can be estimated simultaneously using the FIML method. Generally, an endogenous switching model can be fitted one equation at a time (participation and outcome equations) by either two step least squares or maximum likelihood estimation (Kimhi, 1999; Lokshin & Sajaia, 2004). However, both methods are inefficient and yield inconsistent standard errors. Alternatively, the endogenous switching model can be estimated simultaneously using FIML estimation. This method yields consistent standard errors. Our study uses the “movestay” command provided by STATA for the FIML method. The robust option is implemented to receive robust variance estimates.

According to Lokshin and Sajaia (2004), the coefficients of the ESR model can be employed to estimate an ATT and an ATU. ATT is the difference between the actual and counterfactual outcomes of households participating in AC services (equation 6.4). Similarly, ATU is the difference between the counterfactual and actual outcomes of non-participants (equation 6.5).

$$ATT = E(y_{iP} | D_i = 1) - E(y_{iN} | D_i = 1) \quad (6.4)$$

$$ATU = E(y_{iP} | D_i = 0) - E(y_{iN} | D_i = 0) \quad (6.5)$$

Regarding binary outcomes, this study uses the ESP model to evaluate the effects of AC service participation on binary household welfare characteristics (that is, school enrolment, the adoption of improved farm technologies and practices, and health access improvement). Our study involves three effect indicators and two AC services; AC credit and non-credit support services. Hence there are six ESP models in our study. From here on, we discuss the ESP model in terms of the effect of participation in AC credit and non-credit support services on school enrolment rates. The ESP model is also used to examine the effect of AC service participation on the adoption of improved farm technologies and practices and also for health access improvement. These models function in the same way as the ESP model for school enrolment rates.

The ESP model involves two stages. The first stage determines the probability of a household's decision to participate in AC services using the probit model (equation 6.1). The second stage specifies the outcome equations for AC service participants (equation 6.6) and non-participants (equation 6.7). Since the effect indicators are binary variables, the second stage uses the probit model to examine the relationship between the effect and explanatory variables, conditional on the choice of AC service participation. The ESP model is given as:

$$y_{1i}^* = \beta_1 x_{1i} + \mu_{1i} \text{ with } y_{1i} = \begin{cases} 1 & \text{if } y_{1i}^* > 0 \\ 0 & \text{if } y_{1i}^* \leq 0 \end{cases} \text{ if } D_i = 1 \quad (6.6)$$

$$y_{0i}^* = \beta_0 x_{0i} + \mu_{0i} \text{ with } y_{0i} = \begin{cases} 1 & \text{if } y_{0i}^* > 0 \\ 0 & \text{if } y_{0i}^* \leq 0 \end{cases} \text{ if } D_i = 0 \quad (6.7)$$

Where y_{1i}^* and y_{0i}^* are the latent variables for y_{1i} and y_{0i} , respectively; y_{1i} and y_{0i} are the observed effect variables for AC participants and non-participants. The observed effect variable is binary. y_{1i} which equals one if AC service participants send every school-aged child in their family to school, and zero otherwise. y_{0i} equals one if non-AC service participants send every school-aged child in their family to school, and zero otherwise.

ESP model equations (equations 6.1, 6.6, and 6.7) are estimated simultaneously using the FIML method. The FIML method yields consistent standard errors (Lokshin & Sajaia, 2011). This study uses the “switch_probit” command with the robust option provided by STATA for the FIML method to obtain the consistent standard error and robust variance estimates.

After estimating the ESP model, this study calculates ATT and ATU from the estimated coefficients of the ESP model. According to Lokshin and Sajaia (2011), ATT is the difference between the probability that AC service participants send every school-aged child in their family to school (an actual probability) and the probability of sending every school-aged child to school for the AC service participants if they do not participate in AC services (a counterfactual probability). ATU is the difference between the probability of sending every school-aged child to school for non-AC service participants if they participate in AC services (a counterfactual probability) and the probability that non-AC service participants send every school-aged child to school (an actual probability). ATT and ATU can be expressed as:

$$ATT = \frac{1}{N_1} \sum_{i=1}^{N_1} \left[\Pr(y_1 = 1 | D_i = 1, X = x) - \Pr(y_0 = 1 | D_i = 1, X = x) \right] \quad (6.8)$$

$$ATU = \frac{1}{N_0} \sum_{i=1}^{N_0} \left[\Pr(y_1 = 1 | D_i = 0, X = x) - \Pr(y_0 = 1 | D_i = 0, X = x) \right] \quad (6.9)$$

Where $\Pr(y_1 = 1 | D_i = 1, X = x)$ is the probability that AC service participants send every school-aged child to school (an actual probability for participants). $\Pr(y_0 = 1 | D_i = 1, X = x)$ is the probability of sending every school-aged child to school for AC service participants if participants do not participate in AC services (a counterfactual probability for participants).

$\Pr(y_1 = 1 | D_i = 0, X = x)$ denotes the probability of sending every school-aged child to school for non-AC service participants if they participate in AC services (a counterfactual probability for non-participants). $\Pr(y_0 = 1 | D_i = 0, X = x)$ denotes the probability that non-AC service participants send every school-aged child to school (an actual probability for non-participants). N_1 and N_0 are the sample numbers for AC service participants and non-participants, respectively; Φ_2 is the cumulative function of a bivariate normal distribution; and F is a cumulative function of the univariate normal distribution.

6.2 Tests for Exclusion Restriction

For consistency, both ESR and ESP models require at least one explanatory (a selected IV) to be included in the participation equation (equation 6.1). The IV must not appear in the outcome

equations. This indicates that the selected IV significantly influences a household's decision to participate in AC services but does not influence their welfare. Our study employs two selected IVs: AC neighbour membership (AC_Rel_a) and the presence of AC in a household's village (AC_Vill). Hoken and Su (2015), Ito et al. (2012), and Ma and Abdulai (2016) employ AC neighbour membership (AC_Rel_a) as IVs to estimate the probability of AC participation. AC neighbour membership reflects a household's AC experience, as narrated by other people. All of these studies find that households who obtain information about ACs from others living close to them are more likely to participate in ACs. The last IV is the presence of a cooperative in a household's village. Ma and Abdulai (2016) find that the presence of an AC in a farmer's village in China significantly affects his/her decision to participate in ACs since he/she can easily access support.

To check the validity of a selected IV, this study adds an IV as an explanatory variable in the participation and outcome equations in the ESR model. The study applies the probit model to the participation equations (equation 6.1) and the OLS regression in the outcome equations (equations 6.2 using the entire sample). Both equations are separately estimated. The study includes two AC services (credit and marketing services) and five continuous outcomes; thus, there are 10 ESR models used to test the validity of the selected IV. The results show that AC neighbour membership (AC_Rel_a) is statistically significant in AC credit participation at the 1% level, but not significant in household consumption and educational expenses (see Appendices B.4 and B.5). This result indicates that AC neighbour membership is a valid IV for the AC credit model with effects on consumption and educational expense. The presence of an AC in a village (AC_Vill) is valid as the selected IV for the AC credit model in terms of effects on household and farm income, and health affordability. The presence of an AC in a farmer's village (AC_Vill) significantly influences a household participation in AC credit services at the 1% level but does not influence those outcomes (see Appendices B.2, B.3, and B.6).

AC neighbour membership (AC_Rel_a) is a valid IV for the AC marketing service model with effects on household income and consumption. AC neighbour membership (AC_Rel_a) significantly affects a household's decision to participate in AC marketing services at the 1% level but does not affect household income and consumption expenditure (see Appendices B.2 and B.4). The presence of an AC in a farmer's village (AC_Vill) is a valid selected IV for the AC marketing service model with effects on farm income, education expense, and health affordability models. The presence of an AC in a village (AC_Vill) significantly influences household participation in AC marketing services at the 1% level, but does not affect farm income, educational expenses, and health affordability (see Appendices B.3, B.5, and B.6)

For the ESP models, the study adds an IV as an explanatory variable in the participation and outcome equations and then estimates them separately to test the validity of selected IVs. The study applies the probit model for both participation (equation 6.1) and outcome equations (equation 6.6 using the entire sample). Our study involves three effect indicators (school enrolment, adoption of improved farm technologies and practices, and improvement of health access) and two AC services (credit and non-credit support services). Our study tests the validity of the selected IVs for all six ESP models.

AC neighbour membership (AC_Rel) is a valid IV for the AC credit model on the effects on school enrolment, adoption of improved farm technologies and practices, and the improvement of health access. AC neighbour membership (AC_Rel) significantly influences a household's decision to participate in AC credit at the 1% level, but does not influence school enrolment, the adoption of improved farm technologies and practices, and improved health access (see Appendices B.7 to B.9).

In terms of non-credit support service model, AC neighbour membership (AC_Rel) is a valid IV for the AC marketing service model with health access improvement effect (see Appendix B.9). Similarly, AC neighbour membership (AC_Rel) is significant in terms of participation in agricultural extension services at the 1% level, but not for the adoption of improved farm technologies and practices (see Appendix B.8). The presence of an AC in a farmer's village (AC_Vill) is a valid IV for the AC marketing service model with effect on school enrolment. The presence of an AC in a farmer's village (AC_Vill) is statistically significant on a household decision to trade with ACs at the 1% level, but not significant on school enrolment (see Appendix B.7).

6.3 Result and Discussion

This section discusses the estimated results of the ESR and ESP models and the effects of AC service participation. As discussed in section 4.2.2, both ESR and ESP models consist of participation and outcome equations. These equations are estimated simultaneously using FIML estimation. In short, the ESR and ESP models provide the estimated result for determinants of household participation in AC services and household welfare. This section discusses the determinants of household participation in AC services; credit, marketing, and agricultural extension services, the determinants of household welfare, and average treatment effects for both participants and non-participants in AC services.

6.3.1 Determinants of Household Participation in Agricultural Cooperative Services

Determinants of a household's decision to participate in AC services are estimated using the ESR and ESP models. Since this section considers factors affecting a household's decision to participate in AC services, the sample includes both groups (participants and non- AC participants – a total of 850

respondents). The estimated results of both models are similar with the results of determinants of AC members' decisions to participate in AC services (see Chapter 5). Chapter 5 focuses on AC members' decisions to participate in AC services, thus, the sample only includes AC members. To avoid repetition, this section discusses the determinants which are strongly correlated with AC service participation.

Determinants of Household Participation in AC Credit

The estimated coefficients of the participation equation on why households choose to participate/not participate in AC credit are reported in the first column of Tables 6.1 - 6.9. The participation variable in AC credit is regressed on individual characteristics, household factors, household perceptions of farm risks, geographical factors, and an IV. The Wald χ^2 is statistic significantly at the 99% confidence level, indicating that explanatory variables are jointly statistically significant.

The probability of participation in AC credit is statistically and significantly influenced by farm size, access to agricultural extension services, financial risk, distance to the nearest market, relatives being an AC member, the presence of an AC in village, and neighbours' attitude on ACs at the 1% level. In addition, age, crop type, land ownership, and the northern districts of Nakhon Ratchasima (Phimai, Buayai, Nonsong districts) are significant at the 5% level. All factors which are significant at 1% level have positive impacts on AC credit participation. The findings show that households who have larger farms, higher financial risk, and access to agricultural extension services are more likely to participate in AC credit. The effect of farm size on AC credit participation supports the findings of previous studies (Duong & Izumida, 2002; Duy et al., 2012; Nguyen, 2007; Tetteh Anang et al., 2015). Farm size reflects farm production scale. Households with larger farms (land size) need more capital to invest in farm production than those with smaller land holdings. Therefore, an increase in farm size by one rai raises the probability of borrowing loan from ACs (Tetteh Anang et al., 2015). However, the probability of AC credit participation will decrease when farm size reaches a certain level: mid-sized farmers have the maximum probability of borrowing money from ACs (see Table 6.9). This is because small farmers are not seen as creditworthy, thus they are often unable to access AC credit. Larger farmers can access formal credit so they tend to borrow money from formal lenders such as the BAAC due to lower interest rates.

Similarly, access to agricultural extension services positively affects a household's decision to participate in AC credit, indicating that households who access agricultural extension services are more likely to borrow money from ACs. As they can access improved farm technologies and practices, they are more likely to borrow loans to invest in farm technologies, eventually improving their production levels (Girma & Abebaw, 2015; Tetteh Anang et al., 2015). Moreover, the findings

show that financial risk has a positive impact on AC credit participation, suggesting that the more financial risk households confront, the higher their probability of participation in AC credit. This finding supports Fongthong and Suriya (2014) and Menkhoff and Rungruxsirivorn's (2011) studies, which report that Thai households with lower incomes or higher financial risk tend to borrow loans from village funds or ACs rather than the BAAC.

Household participation in AC credit is dominated by AC relative membership (AC_Rel) and neighbour's attitude to ACs (Comm_Att). AC relatives and neighbour's attitude significantly and positively influence the probability of AC credit participation at the 1% level (see Tables 6.1 -6.9). These results reflect the role of social networks in encouraging households to participate in AC credit. Social networks are important in terms of sharing information or experiences between current AC service participants and potential participants. The survey data shows that around 91% of the AC participants obtain information about ACs and AC services from other people. They use this information to determine whether to participate in AC services. Therefore, households who have AC relatives and obtain information from them are more likely to borrow credit from ACs. This result is similar to Ito et al. (2012) and Ma and Abdulai's (2016) studies on AC participation in China.

Lastly, distance to town and AC located in village positively influences AC credit participation. Distance to town refers to the accessibility of formal credit services (Khoi, 2012). Households who live far away from town have difficulty accessing formal credit services (Duy et al., 2012; Nguyen, 2007). Therefore, the further a household lives from formal credit services, the more likely that they will borrow from an AC. The result is consistent with Abebaw and Haile (2013), Mojo et al. (2017), and Wossen et al.'s (2017) studies. Similarly, the presence of an AC in a village has a positive influence on AC credit participation. This result indicates that households living in the same village as an AC(s) are more likely to borrow from them since they easily access AC services. This result is in line with Abebaw and Haile (2013) and Mojo et al.'s (2017) studies.

Determinants of Household Participation in Non-AC Credit Support Services

This study divides non-credit AC support services into marketing services and agricultural extension services. The ESR and ESP model results for the determinants of a household's decision to participate in AC marketing and agricultural extension services are reported in the fourth column of Tables 6.1-6.9. The Wald χ^2 is statistically significant at the 99% confidence level, indicating that the explanatory variables are jointly statistically significant.

The estimated results of participation in AC marketing services show that farm size, credit use, access to agricultural extension services, relatives being AC members, neighbours' attitude to ACs, the presence of an AC in a village, and districts in the South of Nakhonratchasima are statistically significant at the 1% level (see Tables 6.1 -6.9). All significant factors have positive effects on AC

marketing participation, except for the southern districts of Nakhonratchasima. As expected, farm size has a significant and positive effect on participation in AC marketing services, consistent with Bernard and Spielman (2009), Fischer and Qaim (2012,2014), Ma and Abdulai (2016), Mensah et al. (2012), Muthyalu (2013), and Zhang et al.'s (2017) studies. Farm size relates to farm production capacity. The larger the farm (land size), the greater amount of input farmers need in order to produce the maximum yield. Farmers with larger farms are more likely to purchase farm inputs and sell outputs to AC marketing services. However, the probability of AC marketing service participation decreases at a certain farm size. These findings confirm that middle class households have the greatest probability of participation in AC marketing services. Small farmers may not have enough produce to trade with ACs thus limits the benefits from participating. In contrast, larger farmers may obtain higher profits when they individually trade because their bargaining power increases. Hence, larger farmers are more likely to sell their own produce.

Credit use and access to agricultural extension services significantly and positively influence AC marketing participation at the 1% level. This finding suggests that households who access credit and agricultural extension services are more likely to buy farm inputs and sell their products to AC markets. The effects of credit use and access to agricultural extension services on AC marketing participation are consistent with Fischer and Qaim (2012) and Alene et al.'s (2008) studies. One explanation is that ACs in the study area provide credit, either in the form of cash or credit for input purchases. When households obtain credit from ACs, they are more likely to buy farm inputs from them. ACs require good quality products to sell to the market. Households who access agricultural extension services must meet AC standards, thus they have a higher probability of selling their farm products to ACs.

In addition to household characteristics, AC marketing participation is influenced by a household's social networks and AC location. These findings show that probability of participating in AC marketing is positively connected to AC relative membership (AC_Rel) and neighbours' attitudes to ACs (Comm_Att). These variables reflect the crucial effects of neighbours' experiences of ACs. This result is consistent with Fischer and Qaim (2012; 2014) and Mensah et al.'s (2012) studies. Our finding indicates that household neighbours are an important source of information. AC location is another important factor which positively affects AC marketing participation. This finding is consistent with Alene et al. (2008), Chagwiza et al. (2016), Fischer and Qaim (2012), Muthyalu (2013), and Winter-Nelson and Temu's (2005) results. AC location refers to the distance from farm to ACs, or transaction costs (Winter-Nelson & Temu, 2005). Households living in an AC village can easily access markets, thus they are more likely to purchase inputs and sell their products to ACs. Households in the southern districts, Pakchong and Pakthongchai, are less likely to trade with ACs compared to the Dankhontod district (reference dummy). This is because Pakchong and Pakthongchai districts are

mountainous, thus, transaction costs are higher than the Dankhuntod district which is flat (see Tables 6.1 -6.9).

The estimated results of the probit model for AC agricultural extension services show that the probability of participation is significantly influenced by cash crops, credit use, financial risk, AC relatives, the presence of an AC in the village, and the northern districts of Nakhonratchasima at the 1% level (see Table 6.7). Age, gender, paddy farming, and orchard farming significantly influence a household's probability of participation in AC agricultural extension services at the 5% level. For household characteristics, the results show that households with an elderly female head are more likely to participate in AC agricultural extension services. However, the probability of participation in these services drops at a certain level of age. This finding is similar with Atsan et al. (2009), Egziabher et al. (2011), and Wossen et al.'s (2017) results, who all argue that the elderly are less likely to join agricultural extension services since it is difficult for them to adopt new technologies.

The probability of participation in AC agricultural extension services reduces with paddy and orchard farms but increases with cash crop farms. Orchard farming is not common in the chosen study areas, thus none of the ACs provide agricultural extension services to support orchard production. Rice farmers are less likely to participate in AC agricultural extension services since they are the largest group and they tend to use traditional methods (69% of respondents use traditional methods). They are not interested in implementing new technologies and practices; hence they are less likely to participate in AC agricultural extension services.

Households with higher financial risk and access to credit are more likely to participate in AC agricultural extension services. This result is similar to Wossen et al. (2017), Tiwari et al. (2008) and Ma's (2016) studies. Our result indicates that households who do not face liquidity constraints are more likely to join AC agricultural extension services, because they can afford to pay for them.

Our result shows that social network (AC relative membership) is positively significant in terms of a household's decisions to participate in AC agricultural extension services. This finding is consistent with prior studies (Abebaw and Haile, 2013; Egziabher et al., 2011; Elias et al., 2013; Tiwari et al., 2008), which argue that current AC members share their experiences of using improved farm technologies/practices and extension services. Hence, households who have neighbours or relatives in ACs are more likely to participate in agricultural extension services. Households in the northern districts of Nakhonratchasima and those living in AC villages are more likely to participate in agricultural extension services. One reason may be that they have easier access to agricultural extension services.

6.3.2 Effect of Agricultural Cooperative Services on Household Economic Welfare

This section discusses the empirical results of the effects of AC credit and non-credit support service participation on household and farm incomes, and consumption. The ESR model results are reported in Tables 6.1-6.3. Each table contains two sets of results: one for AC credit participation and the other for AC marketing service participation. While the second and third columns outline the determinants of income and consumption for participants and non-participant in AC credit, the last two columns show the determinants of income and consumption for participants and non-participants in AC marketing services. The results also present the ATT and the ATU.

Effects of AC Services on Household and Farm Income

This section discusses the income effects of participation in AC credit and non-credit support services. Among AC non-credit support services, input and output marketing services directly relate to household income; participation in AC marketing services is thus used as a treatment variable for evaluating the effects of AC non-credit support services on household income. The FIML estimates of the ESR models for household and farm income effects of participation in AC credit and AC marketing services are reported in Tables 6.1 and 6.2, respectively.

Table 6.1 provides the estimated results of household income. It compares those who use AC credit services with those who do not (the second and third columns) and those who use AC marketing services with those who do not (the fifth and sixth columns). The Wald χ^2 for both AC credit and marketing services is significant at the 99% confidence level, indicating that the explanatory variables are jointly statistically significant. Regarding the AC credit model, the coefficients of correlation (ρ) between the participation equation and household income functions for participants (ρ_{PC}) and non-participant (ρ_{NC}) are negative, but not significantly different from zero. This result implies that the selection bias arising from unobserved factors is not an issue for the AC credit model.

Table 6.1 Effects of AC Credit and AC Marketing Service Participation on Household Income using the Endogenous Switching Model (ESR)

Variables	AC Credit			AC Marketing		
	Participation (Y/N)	Household Income		Participation (Y/N)	Household Income	
		Participants	Non- Participants		Participants	Non- Participants
Individual Characteristics						
IgAge	-0.043 (0.290)	0.298* (0.162)	-0.228 (0.178)	0.277 (0.263)	0.358** (0.178)	0.059 (0.163)
IgEdu	-0.100 (0.131)			0.177 (0.123)		
Paddy	-0.429** (0.173)	-0.334*** (0.088)	-0.311* (0.170)	-0.024 (0.162)	-0.216* (0.111)	-0.370*** (0.117)
Orchard	-0.225 (0.245)	0.248 (0.229)	0.401** (0.189)	-0.252 (0.224)	0.298 (0.269)	0.405** (0.184)
Cash_Crop	0.317* (0.165)	-0.010 (0.093)	0.008 (0.140)	0.012 (0.146)	0.037 (0.119)	-0.011 (0.102)
Household Characteristics						
IgHHmem	-0.220* (0.134)	0.497*** (0.076)	0.601*** (0.101)	-0.259** (0.127)	0.324*** (0.108)	0.609*** (0.081)
Dep_Rat	-0.115 (0.081)	3.97e-05 (0.049)	-0.123** (0.052)	0.122* (0.069)	0.008 (0.049)	-0.098* (0.053)
IgFarm_Si	0.232*** (0.074)	0.471*** (0.045)	0.316*** (0.058)	0.418*** (0.066)	0.505*** (0.074)	0.286*** (0.055)
Farm_Ass	-0.174 (0.117)	0.007 (0.070)	-0.115 (0.085)	0.100 (0.106)	0.036 (0.084)	-0.154** (0.069)
Land	-0.405** (0.180)	0.091 (0.090)	-0.062 (0.132)	0.053 (0.160)	-0.034 (0.111)	-0.008 (0.107)
Oth_Loan, Cre_Use	-1.87e-07 (3.04e-07)	2.44e-07 (2.13e-07)	7.75e-07*** (1.74e-07)	0.439*** (0.130)	-0.044 (0.136)	-0.028 (0.090)
Irr_Acc	-0.119 (0.111)	0.083 (0.064)	0.170** (0.079)			
Commer	0.094 (0.124)	0.217 (0.186)	0.267*** (0.083)	-0.014 (0.099)	0.367* (0.205)	0.277*** (0.076)
Off_Farm				0.054 (0.112)	0.219*** (0.084)	0.416*** (0.089)
Ext_Acc	0.807*** (0.121)			0.304*** (0.112)		
Household Perceptions of Risk						
Pro_Risk	-0.076 (0.072)	0.067 (0.041)	0.044 (0.051)	-0.039 (0.068)	0.081* (0.044)	0.025 (0.048)
Mkt_Risk	-0.014 (0.077)	0.006 (0.044)	-0.185*** (0.068)	0.111 (0.070)	-0.014 (0.054)	-0.094* (0.052)
Fin_Risk	0.233*** (0.062)	-0.162*** (0.037)	-0.291*** (0.041)	0.043 (0.059)	-0.164*** (0.040)	-0.238*** (0.040)

Table 6.1 Effects of AC Credit and AC Marketing Service Participation on Household Income using the Endogenous Switching Model (ESR) (cont.)

Variables	AC Credit			AC Marketing		
	Participation (Y/N)	Household Income		Participation (Y/N)	Household Income	
		Participants	Non- Participants		Participants	Non- Participants
<i>Geographic and Related Factors</i>						
IgDis	0.292*** (0.056)					
Dist_N	0.309** (0.145)			-0.226* (0.120)		
Dist_S	-0.171 (0.150)			-0.335*** (0.123)		
AC_Rela	0.941*** (0.147)			0.597*** (0.157)		
AC_Vill	0.569*** (0.185)			0.315 (0.213)		
Comm_Att	0.255*** (0.032)			0.157*** (0.043)		
Constant	-2.428* (1.409)	9.176*** (0.752)	12.350*** (0.890)	-4.670*** (1.298)	8.887*** (0.838)	10.63*** (0.797)
Sigma		0.646*** (0.045)	0.724*** (0.041)		-0.570*** (0.091)	0.8294* (0.109)
Rho		-0.072 (0.149)	-0.162 (0.205)		-0.142 (0.308)	-0.809** (0.566)
Wald Test of Indep. Eqns.			0.83	4.30**		
Observations			839	839		
Wald Chi2			308.62***	180.60***		

Note: 1. *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.
2. Robust Standard Errors are in given brackets
3. Computed by the authors using 2017 survey data.

For the AC marketing model, both correlation coefficients (ρ_{PM} , ρ_{NM}) have the same sign; however, only the correlation coefficient for non-participants (ρ_{NM}) is significant (see Table 6.1). This result indicates the presence of a selection bias arising from unobservable factors in the AC marketing model (Lokshin & Sajaia, 2004). The finding suggests that observable and unobservable factors influence a household's decision to trade through ACs and ultimately their incomes. The negative and significant correlation coefficient for the non-participant group (ρ_{NM}) suggests a positive selection bias, indicating that households who obtain a higher household income (than the average income) are not as likely to participate in AC marketing services. In contrast, the insignificant correlation coefficient for participants indicates that households who participate in AC marketing services do not have a similar income to the average income.

Furthermore, the Wald test for joint independence of the three equations is not statistically significant ($\chi^2 = 0.253$) for the AC credit model; however, it is significant at the 5% level for AC marketing services ($\chi^2 = 5.620$). This result indicates that the error term of selection and income

equations are related; therefore, participation and household income equations for the AC marketing service model are statistically and significantly jointly determined. Ignoring the selection bias in the AC marketing model will lead to biased results. Using the ESR model for AC marketing services will mitigate the selection bias.

Regarding household income effect, the ESR results are mostly consistent between the AC credit and the AC marketing service models. This finding shows that participants and non-participants' household incomes are significantly influenced by age, crop type, number of household members, farm size, commercialization level, off-farm work, and financial and market risks (see Table 6.1). Regarding individual characteristics, age has a significant and positive effect on household income for AC credit participants at the 10% level and AC marketing services at the 5% level, but not for non-participants. This result indicates that older participants in AC services obtain higher household incomes. This is probably because they have more farm production experience, thus they can earn relatively more (Jena et al., 2012). This result is in the line with Jena et al.'s (2012) study, which concludes that younger household heads earn less per capita income than older household heads. However, our findings contradict Ma and Abdulai's (2016) study which concludes that older non AC participants have higher household incomes.

In terms of crop type, our results indicate that paddy farms are negatively significant in terms of household income for both participants and non-participants in AC credit and AC marketing service models. This result indicates that rice farmers earn less than other farmers whether they participate in AC services or not (see Table 6.1). The survey data reveals that the difference in household incomes between rice farmers and other farmers is the result of differences in farm income. The t-test result indicates that rice farmers earn significantly less farm income than other farmers at the 1% level ($t\text{-value} = 4.8330$) (see Appendix C.3). While the average rice farmer's income is 89,249 baht per year, other farmers earn 378,710 baht. This could be the result of drought and reductions in the price of rice in the crop year 2015/16; during this period farmers had lower rice yields and less income (Office of Agricultural Economics, 2016). Those who do not use AC credit or marketing services and who grow orchards including vegetables and fruits have higher incomes than those who grow other crops because of the high fruits and vegetables prices.

As expected, the coefficients of number of members in family and farm size are positive and significantly different from zero, for both participants and non-participants, in every model. Household size refers to the number of members who earn income, while farm size refers to production scale. Larger households who have more land have higher household incomes. This finding is contrary to Jena et al. (2012) and Ma and Abdulai's (2016) results. They study the effects of AC membership on per capita household income and find that larger household size decreases per

capita household income as more family members do not increase their farm yields or their net return. Off-farm work has a positive and significant effect on whether farmers join AC marketing services or not. One explanation is that off-farm activities provide additional income for households (Jena et al., 2012).

Regarding production and sale characteristics, ratio of sales to yields are positively significant in terms of household income for non-participants in AC credit and AC marketing models, at the 1% level. This result suggests that a higher sales ratio increases a household's income. This finding is consistent with Jena et al.'s (2012) finding. Similarly, irrigation access positively influences non-participants' incomes for the AC credit model but not significantly for AC credit participants (see Table 6.1).

In terms of household perceptions of agricultural risks, financial risk significantly and negatively influences household income at the 1% level, for both participant and non-participant, in AC credit and AC marketing models. This implies that increased financial risk reduces household income, whether the household chooses to participate in AC services or not. However, market risk has a statistically negative effect only on non-participants in the AC credit model at the 1% level and the AC marketing service model at the 10% level. This result indicates that non-participants will have higher household incomes when they have lower market risks.

Regarding farm income, the significant Wald χ^2 for both AC credit and marketing service models shows that the explanatory variables are jointly statistically significant at the 1% level (see Table 6.2). The Wald test for joint independence of the three equations for both models are statistically significant, at the 1% level for the AC credit model, and the 5% level for the AC marketing service model. This result confirms the joint significance of the error correlation coefficients of the participation and farm income equations. Both the AC credit and marketing models must account for the selection bias.

For the AC credit model, the coefficients of correlation (ρ) between the participation equation and farm income functions for participants (ρ_{PC}) and non-participant (ρ_{NC}) are significantly different from zero, at the 1% level. This result indicates the presence of a selection bias. Unobserved factors influence a household's decision to participate in AC credit services and ultimately impact on farm income. Both correlation coefficients (ρ_{PC} , ρ_{NC}) have the same sign, indicating that AC borrowers' farm incomes are higher than average farm incomes regardless of AC credit participation; however, they are better off participating. In contrast, non-AC borrowers' farm incomes are lower than average farm incomes, irrespective of AC credit participation; they are better off not participating (Alene & Manyong, 2007).

In the AC marketing service model, the coefficients of correlation between the participation equation and participants' farm incomes are not significant, while the coefficients of correlation between the participation equation and non-participants' farm incomes are statistically significant at the 5% level. The negative correlation coefficients suggest that households whose farm incomes are higher than the average farm income are less likely to trade with ACs.

Farm income is significantly influenced by crop type, farm size, other credit use, sales ratio, and financial risk (see Table 6.2). The coefficients of crop type show that rice farming has a positive and significant impact on participants' farm incomes at the 1% level for AC credit and marketing service models. This result suggests that rice farmers who participate in AC services earn higher farm incomes than those who do not. One explanation could be that ACs in the Northeast of Thailand have strong networks and have succeeded in adding value to their products (Thuvachote, 2007). They produce better quality rice under their own premium brand which they sell at a higher price. This result suggests that ACs in our study areas succeed in improving rice farmers' farm incomes, thus, participating in AC services in Nakhonratchasima province is a good choice for rice farmers. In contrast, ACs in Nakhonratchasima province is not successful in assisting cash crop farmers. Our results indicate that AC credit and marketing services cannot increase cash crop farmers' farm incomes. The relationship between farm income and cash crop farming is significantly negative at the 1% level for AC credit participants and at the 5% level for the AC marketing service participants. These results indicate that cash crop farmers who borrow credit and trade with ACs earn less farm income than those growing other crops. This difference in income could be attributed to drought in the crop year 2015/16 and diseases which affected their crops. In the crop year 2015/16, cash crop, particularly corn and sugar cane were poor quality and did not sell well thus farmers gain low price (Office of Agricultural Economics, 2016). For orchard farming, the results show that farm income significantly increases at the 5% level for AC marketing service participants and at the 1% level for non-participants. This finding suggests that orchard farmers earn higher farm incomes than other farmers, no matter which market channel they use to sell their products. One possible explanation is that the prices of fruits and vegetables are higher than rice and cash crop prices.

The coefficients of farm size have a positive and significant effect on farm income for both participants and non-participants in AC credit and AC marketing models, at the 1% level. This result indicates that larger farms have significantly higher farm incomes, whether they participate in AC services or not. The relationship between farm size and farm income is contradictory to earlier studies which have found that larger farms have lower farm incomes due to lower levels of productivity. For example, Ma and Abdulai (2016) find that larger farms earn less due to the lower apple yields per mu (1 mu equals 1/15 hectare).

Table 6.2 Effects of AC Credit and AC Marketing Service Participation on Farm Income using the Endogenous Switching Model (ESR)

	AC Credit			AC Marketing		
Variables	Participation (Y/N)	Farm Income		Participation (Y/N)	Farm Income	
		Participants	Non- Participants		Participants	Non- Participants
Individual Characteristics						
lgAge	-0.015 (0.283)	0.160 (0.404)	-0.964 (0.704)	0.167 (0.277)	0.229 (0.451)	-0.527 (0.459)
lgEdu	-0.118 (0.125)	-0.041 (0.171)	-0.316 (0.339)	0.072 (0.137)		
Paddy	-0.385** (0.174)	0.429*** (0.161)	-0.127 (0.505)	-0.150 (0.154)	0.583*** (0.173)	-0.350 (0.418)
Orchard	-0.209 (0.243)	0.402 (0.352)	1.002* (0.587)	-0.214 (0.235)	0.699** (0.297)	1.292*** (0.499)
Cash_Crop	0.295* (0.168)	-0.629*** (0.212)	0.275 (0.487)	-0.049 (0.151)	-0.457** (0.232)	0.596 (0.559)
Household Characteristics						
lgFarm_Mem	0.060 (0.132)	0.179 (0.181)	-0.211 (0.367)	0.089 (0.127)	0.456** (0.210)	-0.176 (0.269)
lgFarm_Size	0.202*** (0.072)	1.139*** (0.093)	1.296*** (0.342)	0.419*** (0.069)	0.945*** (0.139)	1.162*** (0.264)
Land	-0.410** (0.176)	-0.219 (0.224)	0.159 (0.455)			
Oth_Loan, Cre_Use	-1.73e-07 (2.94e-07)	-1.82e-07 (1.79e-07)	2.05e-06*** (7.68e-07)	0.368*** (0.132)	0.225 (0.348)	0.065 (0.255)
Irr_Acc	-0.160 (0.172)	-0.051 (0.217)	0.112 (0.417)	-0.263 (0.184)	0.030 (0.261)	0.022 (0.333)
Tech_Acc	0.016 (0.167)	0.290 (0.207)	-0.181 (0.416)	0.365** (0.181)	-0.075 (0.256)	-0.177 (0.317)
Ext_Acc	0.739*** (0.121)			0.386*** (0.120)		
Commer	0.039 (0.105)	9.267*** (0.601)	3.928* (2.244)	-0.225 (0.146)	8.364*** (1.009)	4.603* (2.407)
Household Perceptions of Risk						
Pro_Risk	-0.054 (0.071)	0.015 (0.084)	-0.273 (0.193)	-0.075 (0.067)	-0.030 (0.101)	-0.176 (0.146)
Mkt_Risk	-0.005 (0.077)	0.067 (0.098)	-0.060 (0.219)	0.107 (0.073)	0.168 (0.143)	-0.038 (0.156)
Fin_Risk	0.212*** (0.061)	-0.013 (0.082)	-0.421** (0.177)	0.025 (0.060)	0.011 (0.118)	-0.361** (0.148)

Table 6.2 Effects of AC Credit and AC Marketing Service Participation on Farm Income using the Endogenous Switching Model (ESR) (cont.)

Variables	AC Credit			AC Marketing		
	Participation (Y/N)	Farm Income		Participation (Y/N)	Farm Income	
		Participants	Non- Participants		Participants	Non- Participants
<i>Geographic and Related Factors</i>						
IgDis	0.325*** (0.052)					
Dist_N	0.296** (0.142)	0.324* (0.186)	-0.419 (0.352)	-0.206 (0.140)		
Dist_S	-0.128 (0.150)	-0.094 (0.164)	0.664* (0.379)	-0.292** (0.132)		
AC_Rela	1.024*** (0.153)			0.687*** (0.171)		
AC_Vill	0.515*** (0.175)			0.508*** (0.167)		
Commu	0.251*** (0.031)			0.191*** (0.032)		
Constant	-3.015** (1.328)	-0.380 (1.866)	9.600** (3.988)	-4.063*** (1.338)	-0.081 (2.187)	7.119** (2.781)
Sigma		1.417*** (0.040)	2.830*** (0.102)		1.407*** (0.059)	2.617*** (0.097)
Rho		-0.325** (0.117)	-0.272** (0.120)		-0.069 (0.174)	-0.301** (0.118)
Wald Test of Indep. Eqns.			10.95***	5.90**		
Observations			837	837		
Wald Chi2			680.33***	228.38***		

Note: 1. *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.
2. Robust Standard Errors are given in brackets
3. Computed by the authors using 2017 survey data.

In addition to farm size, access to other credit sources has a positive effect on farm income for non-participants in AC credit at the 1% level. Credit accessibility allows farmers to enhance their farm productions. This finding is consistent with Ma and Abdulai's (2016) study. Sale ratio is positive and statistically significant at the 1% level with respect to farm income for both AC credit and marketing service participants. In short, households earn more farm income when the portion of sale on yields increases. In terms of household perceptions of risks, financial risks are negative and statistically significant for non-participants' farm income, in both AC service models, at the 1% level. This finding indicates that the higher a household's financial risk, the less farm income they will earn (see Table 6.2).

Effects of AC Services on Household Consumption

The estimated results for effects of participation in AC credit and AC marketing services on household consumption expenditure using the FIML approach are illustrated in Table 6.3. The second and third columns in Table 6.3 present the determinants of household consumption expenditure for the AC credit model, while the fifth and sixth columns show the determinants of household consumption expenditure for the AC marketing model. The ESR results show that the Wald χ^2 for both AC credit and marketing services models are significant at the 1% level. This result indicates that the explanatory variables are jointly statistically significant.

The correlation coefficients (ρ) between the participation equation and the household consumption function for both AC credit and AC marketing models are not significantly different from zero. This result indicates that a household's decision to participate in AC credit and AC marketing services and their consumption expenses are not influenced by unobservable factors. Therefore, there is no selection bias for both the AC credit and AC marketing models. Similarly, for the AC marketing service model, the Wald test result for joint independence of the three equations is not significant ($\chi^2=0.86$), confirming that the error terms of participation and household consumption equation are not related. However, the Wald test result for joint independence of the three equations for the AC credit model is significantly different from zero at the 10% level ($\chi^2=3.26$). This result suggests that the error term of selection and household consumption equations are associated. Participation and household consumption equations for the AC credit model are statistically and significantly jointly determined. Therefore, using the ESR model for AC credit controls for the selection bias.

The ESR results show that the determinants of household consumption for both the AC credit and AC marketing models are similar. Coefficients of age are significantly negative at the 1% level for non-participants in AC credit and AC marketing services, and significant at the 5% for participants in AC marketing services (see Table 6.3). This result indicates that households with older household heads spend less in terms of consumption. These findings are in line with Jena et al.'s (2012) study, which finds that the per capita consumption of small-scale farmers in Ethiopia is negatively influenced by age and positively affected by age squared.

Regarding household factors, the number of members in a family significantly and positively affects household consumption at the 1% level, for both participants and non-participants in the AC credit and marketing service models. This result suggest that household consumption increases for each additional household member (see Table 6.3). One possible explanation is that the relatively larger family have a higher number of labours. A family with more members may earn more income, thus they have more money to spend. In contrast, the dependency ratio has a significantly negative relationship with participants' consumption in the AC credit model at the 5% level. This result

indicates that households who borrow from ACs tend to reduce household consumption when their dependency ratio increases. One possible explanation is that they confront liquidity constraints along with less income earning members, so they have less money to spend. This finding is consistent with Ahmed and Mesfin's (2017) study which compares consumption expenditure between AC members and non-members in Ethiopia. The authors find that ACs are effective in improving household consumption for households who have fewer children.

Land ownership is positively related to consumption expenses, but only for participants in AC marketing services. This finding is consistent with Ahmed and Mesfin's (2017) result. AC marketing participants with larger pieces of land have higher consumption levels compared to those with smaller pieces of land. This finding indicates that AC marketing services are effective in improving welfare for AC participants with larger pieces of land. Off-farm work only positively influences consumption for participants in AC credit. This result indicates that household consumption expenditure is greater for households who borrow money from ACs and work in off-farm activities, than those who do not.

In terms of geographic factors, residing in the southern district is positive and significant on consumption expenditures for AC credit participants at the 1% level. This result suggest that AC credit provisions can improve household welfare, but only in the southern areas of Nakhonratchasima. One possible explanation is that the southern districts are tourist hotspots and thus farmers are able to sell their products at a higher price. Households located in the southern districts also have higher levels of consumption. However, AC credit does not influence participants' consumption in other areas (see Table 6.3).

Table 6.3 Effects of AC Credit and AC Marketing Service Participation on Consumption Expenditure using the Endogenous Switching Model (ESR)

Variables	AC Credit			AC Marketing		
	Participation (Y/N)	Consumption Expenditure		Participation (Y/N)	Consumption Expenditure	
		Participants	Non- Participants		Participants	Non- Participants
Individual Characteristics						
IgAge	-0.158 (0.288)	-0.230 (0.146)	-0.586*** (0.133)	0.131 (0.300)	-0.455** (0.185)	-0.521*** (0.095)
IgEdu	-0.180 (0.126)	0.131* (0.069)	0.041 (0.072)	0.063 (0.152)		
Paddy				-0.107 (0.154)	-0.158* (0.085)	-0.056 (0.068)
Orchard				-0.164 (0.228)	0.151 (0.138)	-0.010 (0.090)
Cash_Crop				-0.099 (0.155)	-0.061 (0.108)	0.077 (0.060)
Household Characteristics						
IgHHmem	-0.238* (0.133)	0.450*** (0.066)	0.583*** (0.063)	-0.195 (0.131)	0.299*** (0.091)	0.558*** (0.052)
Dep_Rat	-0.093 (0.077)	-0.064** (0.032)	0.016 (0.033)	0.093 (0.070)	0.032 (0.047)	-0.043 (0.028)
IgFarm_Size	0.348*** (0.069)			0.436*** (0.068)	0.149* (0.089)	0.054* (0.031)
Land	-0.467** (0.186)			0.011 (0.170)	0.291*** (0.106)	0.104 (0.077)
Farm_Ass	-0.168 (0.114)					
Oth_loan, Cre_Use	-8.46e-08 (2.78e-07)	3.03e-07*** (9.14e-08)	5.60e-07*** (1.25e-07)	0.407*** (0.132)	0.125 (0.135)	0.179*** (0.054)
Tech_Acc	-0.127 (0.104)	-0.063 (0.049)	-0.085* (0.048)			
Ext_Acc	0.800*** (0.117)			0.398*** (0.119)		
Commer				-0.209 (0.203)		
Off_Farm	0.122 (0.119)	0.111** (0.056)	0.055 (0.055)	0.099 (0.122)	0.099 (0.062)	0.080 (0.050)
Household Perceptions of Risk						
Pro_Risk	-0.109 (0.071)			-0.134* (0.072)		
Mkt_Risk	-0.001 (0.075)			0.116* (0.069)		
Fin_Risk	0.231*** (0.060)			0.025 (0.057)		

Table 6.3 Effects of AC Credit and AC Marketing Service Participation on Consumption Expenditure using the Endogenous Switching Model (ESR) (cont.)

Variables	AC Credit			AC Marketing		
	Participation (Y/N)	Consumption	Expenditure	Participation (Y/N)	Consumption	Expenditure
		Participants	Non- Participants		Participants	Non- Participants
Geographic Factors						
IgDis	0.373*** (0.054)	-0.019 (0.031)	-0.067** (0.027)	0.074 (0.054)	-0.033 (0.040)	-0.063*** (0.022)
Dist_N	0.077 (0.131)	-0.047 (0.062)	0.058 (0.056)	-0.251* (0.138)	-0.065 (0.126)	0.070 (0.052)
Dist_S	-0.155 (0.144)	0.174*** (0.065)	0.074 (0.062)	-0.355** (0.138)	0.084 (0.096)	0.162*** (0.057)
AC_Rela	0.939*** (0.145)			0.602*** (0.192)		
AC_Vill	0.617*** (0.166)			0.564*** (0.179)		
Comm_Att	0.249*** (0.031)			0.158*** (0.048)		
Constant	-2.310* (1.376)	11.49*** (0.658)	12.83*** (0.636)	-3.581** (1.653)	11.84*** (0.852)	12.42*** (0.422)
Sigma		0.494*** (0.049)	0.453*** (0.046)		0.537** (0.159)	0.465*** (0.038)
Rho		0.194 (0.187)	-0.213 (0.150)		0.606 (0.524)	-0.042 (0.247)
Wald Test of Indep. Eqns.						
Observations						
Wald Chi2						

Note: 1. *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.
2. Robust Standard Errors are given in brackets
3. Computed by the authors using 2017 survey data.

Summary of Effects of AC Service Participation on Economic Welfare

The effects of AC service participation on a household's economic welfare are summarized in Table 6.4. Table 6.4 provides estimates for the ATT and ATU by comparing the effects of AC credit and AC marketing service participation on household and farm incomes, and consumption. ATT presents the average effects gained from AC service participation among households who participate. ATU presents the average expected effects of AC service participation that would have happened if non-participants choose to use AC services (counterfactual effect).

The results suggest two important points. Firstly, AC credit and marketing services play important roles in improving household economic welfare. AC credit participation significantly improves household and farm incomes, and consumption for both treated (ATT) and untreated (ATU) groups at the 1% level. Regarding ATT, the results reveal that AC credit significantly increases household income (by 2.38%), farm income (by 12.48%), and consumption (by 2.31%) (see Table 6.4). The results of AC credit on income are inconsistent with Akerele and Akanni's (2014) findings for Nigeria.

They conclude that cooperative credit fails to uplift farmers' welfare since the cooperatives cannot encourage farmers to invest loans into farming. Regardless of the credit source, the income effect is in line with several studies on credit access (Setboonsarng & Parpiev, 2008), suggesting that credit has a positive impact on income. Moreover, the effects of ACs credit on consumption are consistent with Ahmed and Mesfin (2017) and Wossen et al.'s (2017) studies, who both report that Ethiopian and Nigerian ACs increase farm household consumption and that AC members' consumption is higher than non-AC members.

ACs are able to help those who have previously not had access to loans or never considered AC membership. If ACs expand credit to households who have not participated in AC credit previously, this may increase their economic welfare. The findings show that if households who have not previously borrowed money from ACs had done so, they would have had greater household income, farm income, and consumption by 1.06%, 5.43%, and 0.23%, respectively (ATU). If non-participating households borrowed from ACs, they would have had more money to invest in income generation activities. As a result, they would have earned more income and been able to consume more goods and services.

AC marketing services play an important role in raising household and farm income but not household consumption. AC marketing services have significant and positive effects on household and farm income at the 1% level, for both treated and untreated groups. AC marketing services increase participants' household income by 9.60% and farm income by 13.84% (ATT) (see Table 6.4). Similarly, in the untreated sample, non-participants' household and farm incomes would increase by 1.13% and 4.71%, respectively if they traded through AC marketing service (ATU). These results are in line with the findings of Calkins and Ngo, (2010) for Ghana, Fischer and Qaim (2012) for Ethiopia, Wollni and Zeller (2007) for Costa Rica, Bernard et al. (2008) and Ito et al. (2012) for China. AC marketing services increase AC members' farm incomes as they provide low cost farm inputs and offer reasonable prices for farm products. Moreover, in Thailand, ACs allow members to purchase farm inputs using credit. AC members are able to obtain farm inputs in advance and pay later. Purchasing farm inputs on credit assists farmers facing liquidity constraints. However, AC marketing services do not impact household consumption. The effect on household consumption for AC marketing service participants is not significantly different from zero. This result indicates that household consumption does not change whether they trade with ACs or not. Similarly, non-participants would spend less if they used AC marketing services.

Table 6.4 Effects of AC Service Participation on Household Economic Welfare

Outcomes	AC Services	Subsample	Mean Outcome		Average Treatment Effect	T-value	Change (%)
			Actual	Counterfactual			
Household Income	Credit	Participants	12.273	11.988	ATT = 0.285	17.971***	2.38
		Non-Participants	11.977	12.104	ATU = 0.127	7.235***	1.06
	Marketing Services				TH = 0.158		
		Participants	12.342	11.261	ATT = 1.082	64.186***	9.60
		Non-Participants	12.037	12.173	ATU = 0.136	10.503***	1.13
					TH = 0.946		
Farm Income	Credit	Participants	11.348	10.089	ATT = 1.259	19.416***	12.48
		Non-Participants	9.959	10.500	ATU = 0.541	4.043***	5.43
	Marketing Services				TH = 0.718		
		Participants	11.640	10.225	ATT = 1.415	21.975***	13.84
		Non-Participants	10.257	10.740	ATU = 0.483	7.060***	4.71
					TH = 0.932		
Consumption Expenditure	Credit	Participants	11.467	11.208	ATT = 0.258	34.731***	2.31
		Non-Participants	11.353	11.380	ATU = 0.027	3.038***	0.23
	Marketing Services				TH = 0.231		
		Participants	11.435	11.442	ATT = -0.007	-0.743	-0.06
		Non-Participants	11.405	10.900	ATU = -0.504	-67.171***	-4.42

Note: 1. *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.
2. Computed by the authors using 2017 survey data
3. TH stands for transition heterogeneity

Transition heterogeneity (TH), which is the difference between ATT and ATU, is positive for three outcomes (household income, farm income, and consumption), indicating that the average effect of participation in AC credit and marketing services is greater for actual participants (ATT) compared to non-participants, if they had chosen to participate (ATU). This finding suggests that AC services are effective to improve economic welfare for the treated group. They meet the needs of their targeted group since actual participants obtain greater benefits from participation in AC credit and marketing services than non-participants. AC credit is less effective in improving household economic welfare than AC marketing services. ATT in AC credit model is less than AC marketing service model, indicating that trading through AC marketing channels provide households with economic benefits than borrowing AC credit. For instance, in the case of household income, ATT of AC credit participation (0.285) is smaller than the ATT of AC marketing service participation (1.082). The results for farm income and household consumption are interpreted similarly (see Table 6.4).

6.3.3 Effect of Agricultural Cooperative Services on Household Social Welfare

Effect of AC Services on Household Education

The estimated results of participating in AC services on children's education effects are reported in Tables 6.5 and 6.6. In this study, the effects of AC service participation on children's education are measured using annual educational expenditure and school enrolment. The estimation of children's education effect applies to the sub-sample of households who have school-aged children (between 6 and 15 years). While Table 6.5 reports the estimated results of participating in AC credit and marketing services on annual school expenditure for children, Table 6.6 reports the estimated results for school enrolment. The school enrolment variable is a dummy variable. School enrolment equals 1, if all school-aged children in a household attend school, and 0 otherwise.

Tables 6.5 and 6.6 show that the correlation coefficients (ρ) between the participation and outcome equations (educational expenditure for children and school enrolment) are not significantly different from zero, for both the AC credit and AC marketing models. This result indicates the absence of a selection bias arising from unobserved factors. Similarly, the Wald test results for joint independence of the three equations for the AC credit model ($\chi^2 = 0.22$ for educational expense and $\chi^2 = 0.49$ for school enrolment) and the AC marketing service model ($\chi^2 = 0.81$ for educational expense and $\chi^2 = 0.59$ for school enrolment) are not statistically significant. This result suggests that the participation and education outcome equations for both AC service models are not jointly determined.

All signs of the coefficients are as expected. Based on Table 6.5, educational expenditure for AC credit participants is positively influenced by a household head's age and level of education. School expenditure for AC marketing service participants is only positively influenced by the number of household members. Among individual factors, the findings show that AC borrowers who are older

and have greater levels of education spend more on their children's education than younger borrowers with lower levels of education. This finding is similar to Doan's (2011), who argues that highly educated individuals who access AC credit spend more on monthly expenses for their children's education.

As expected, the number of household members has a positive and statistically significant effects on school expenditure for participants in AC marketing service model, at the 5% level. One possible reason is that the number of members in household reflects the number of income earners, thus, household expenditure for their children's education increases with the number of household members.

Regarding determinants of school enrolment effect, a household's capability to support their school-aged children to attend school is strongly determined by household members and the dependency ratio (see Table 6.6). The number of household members and the dependency ratio have significant and negative effects on school enrolment at the 1% level, for both participants and non-participants, in both AC service models. This result indicates that larger households with greater numbers of dependents are less able to send their children to school. Children in households with high dependency ratios are less likely to attend school compared to lower dependency ratio. One possible reason is they are often involved in house or agricultural works. Our survey data shows that most of the family members (66% of family members) work. This is consistent with Thailand Agricultural Census in 2013, which shows that 75% of members in agricultural families are involved in farm activities either full or part time (Chatarat et al., 2018). This implies that some school-aged children in high dependency ratio families must work as labourers to earn money for their family therefore they are more likely to drop out of school and study through a non-formal education.

Table 6.5 Effects of AC Credit and AC Marketing Service Participation on Educational Expenditure using the Endogenous Switching Model (ESR)

Variables	AC Credit			AC Marketing		
	Participation (Y/N)	Educational Expenditure		Participation (Y/N)	Educational Expenditure	
		Participants	Non- Participants		Participants	Non- Participants
Individual Characteristics						
IgAge	-0.025 (0.413)	1.063** (0.417)	-0.170 (0.550)	0.301 (0.387)	-0.169 (0.585)	0.861* (0.515)
IgEdu	-0.207 (0.200)	0.746*** (0.195)	0.078 (0.249)	-0.025 (0.264)	0.327 (0.275)	0.423* (0.254)
Paddy	-0.483** (0.241)					
Orchard	-0.870** (0.377)					
Cash_Crop	0.029 (0.232)					
Household Characteristics						
IgHHmem	0.062 (0.256)	0.309 (0.274)	0.879*** (0.263)	-0.718** (0.350)	0.571** (0.288)	0.104 (0.435)
Dep_Rat	-0.128 (0.110)	-0.004 (0.093)	0.165* (0.087)	0.100 (0.141)	0.126 (0.114)	0.025 (0.135)
Oth_Loan, Cre_Use	1.93e-07 (3.06e-07)	2.27e-07 (1.82e-07)	9.98e-07*** (2.51e-07)	0.157 (0.173)	0.331 (0.298)	0.428* (0.241)
Land				0.007 (0.205)	0.509 (0.322)	0.270 (0.293)
IgFarm_Size	0.269*** (0.095)	0.095 (0.118)	-0.031 (0.095)	0.347** (0.157)	-0.015 (0.139)	0.385 (0.270)
Ext_Acc	0.706*** (0.184)			0.233 (0.322)		
Household Perceptions of Risk						
Pro_Risk	-0.151 (0.112)			-0.303*** (0.075)		
Mkt_Risk	-0.009 (0.126)			-0.023 (0.095)		
Fin_Risk	0.139 (0.085)			-0.100 (0.065)		
Geographic and Related Factors						
IgDis	0.218*** (0.079)					
Dist_N				-0.009 (0.224)		
Dist_S				-0.502* (0.261)		
AC_Rela	0.788*** (0.211)			0.388 (0.856)		
AC_Vill	0.785*** (0.242)			0.509 (0.366)		

Table 6.5 Effects of AC Credit and AC Marketing Service Participation on Educational Expenditure using the Endogenous Switching Model (ESR) (cont.)

Variables	AC Credit			AC Marketing		
	Participation (Y/N)	Educational Expenditure		Participation (Y/N)	Educational Expenditure	
		Participants	Non- Participants		Participants	Non- Participants
Commu	0.263*** (0.048)			0.083 (0.082)		
Constant	-2.233 (1.975)	3.390* (1.897)	8.904*** (2.597)	-1.138 (1.810)	7.926*** (2.709)	4.513* (2.330)
Sigma		1.234*** (0.072)	1.175** (0.075)		1.289 (0.081)	1.450 (0.511)
Rho		0.084 (0.297)	0.076 (0.191)		0.195 (0.264)	0.944 (0.288)
Wald Test of Indep. Eqns.			0.22			0.81
Observations			379			379
Wald Chi ²			22.55***			14.84**

Note: 1. *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.
2. Robust Standard Errors are given in brackets
3. Computed by the authors using 2017 survey data.

Table 6.6 Effects of AC Credit and AC Marketing Service Participation on School Enrolment using the Endogenous Switching Probit Model (ESP)

Variables	AC Credit			AC Marketing		
	Participation (Y/N)	School Enrolment		Participation (Y/N)	School Enrolment	
		Participants	Non- Participants		Participants	Non- Participants
Individual Characteristics						
Age_Yr	0.122** (0.052)	0.029** (0.012)	0.019 (0.013)		0.024 (0.016)	0.025*** (0.008)
Age_Sq	-0.001** (0.0005)					
Edu_Yr	-0.020 (0.023)	0.025 (0.037)	-0.012 (0.040)	-0.021 (0.022)	0.065 (0.050)	-0.007 (0.030)
Household Characteristics						
Hhmem	0.037 (0.053)	-0.211*** (0.073)	-0.376*** (0.094)	-0.110** (0.053)	-0.349*** (0.115)	-0.253*** (0.060)
Dep_Rat	-0.004 (0.114)	-0.695*** (0.166)	-0.349** (0.140)	0.053 (0.106)	-0.671*** (0.193)	-0.452** (0.178)
FarmSi	0.013** (0.006)			0.016** (0.007)	-0.002 (0.004)	0.002 (0.006)
Farm_Sq	-4.66e-05 (2.93e-05)			-5.42e-05 (4.12e-05)		
Inc_PU	-0.179 (0.200)	0.191 (0.299)	-0.103 (0.298)		-0.300 (0.442)	0.114 (0.224)
Land					0.988** (0.419)	0.185 (0.264)
Oth_Loan, Cre_Use	1.12e-07 (2.66e-07)	3.33e-06 (2.60e-06)	7.90e-07 (1.10e-06)	0.214 (0.178)	0.196 (0.381)	0.027 (0.224)
Ext_Acc	0.642*** (0.184)			0.403** (0.180)		
Household Perceptions of Risk						
Pro_Risk	-0.089 (0.108)			-0.231** (0.098)		
Mkt_Risk	-0.020 (0.114)			-0.012 (0.124)		
Fin_Risk	0.113 (0.084)			-0.020 (0.083)		
Geographic and Related Factors						
Dis_Town	0.024*** (0.008)					
Dist_N				-0.209 (0.192)		
Dist_S				-0.611*** (0.191)		

Table 6.6 Effects of AC Credit and AC Marketing Service Participation on School Enrolment using the Endogenous Switching Probit Model (ESP) (cont.)

Variables	AC Credit			AC Marketing		
	Participation (Y/N)	School Enrolment		Participation (Y/N)	School Enrolment	
		Participants	Non- Participants		Participants	Non- Participants
AC_Rela	0.942*** (0.215)			0.964*** (0.257)		
AC_Vill	0.770*** (0.233)			0.622*** (0.229)		
Com	0.247*** (0.046)			0.157*** (0.043)		
Constant	-5.596*** (1.505)	0.606 (0.810)	2.349** (1.038)	-1.024 (0.650)	1.021 (1.322)	1.299* (0.693)
Athro		0.207 (0.367)	0.169 (0.369)		-0.203 (0.637)	1.255 (1.659)
Rho		0.204 (0.351)	0.167 (0.359)		-0.200 (0.612)	0.850 (0.462)
Wald Test of Indep. Eqns.			0.49			0.59
Observations			380			380
Wald Chi ²			111.64***			71.95***

Note: 1. *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.
2. Robust Standard Errors are given in brackets
3. Computed by the authors using 2017 survey data.

Effect of AC Services on Improved Farm Skill Adoption

Table 6.7 provides the estimated results of farm skill improvement for participating and non-participating households in terms of AC credit (the second and third columns) and AC agricultural extension services (the fifth and sixth columns). The Wald test for the AC credit model ($\chi^2 = 227.54$) and the AC agricultural extension service model ($\chi^2 = 216.39$) are statistically significant at the 1% level, indicating that the explanatory variables are jointly statistically significant. For the AC credit model, the coefficients of correlation (ρ) between the participation equation and the outcome functions (farm skill improvement) are negative, but they are not significantly different from zero. This result implies the absence of a selection bias for the AC credit model. Furthermore, the Wald test for joint independence of the three equations is not statistically significant ($\chi^2 = 0.98$), suggesting that participation and outcome equations (farm skill improvement) are not jointly determined for the AC credit model.

Regarding the AC agricultural extension services model, the correlation coefficients for participants and non-participants have the same positive sign and are statistically significant at the 1% level (see Table 6.7). The same positive sign suggests that while participants have an above average probability of adopting farm technologies and practices irrespective of participation in AC agricultural extension services, they are still better off participating. While non-participants have a below average

probability of adopting new technology regardless of participation, they are better off not participating (Alene & Manyong, 2007). Moreover, the Wald test for joint independence of the three equations is statistically significant at the 1% level ($\chi^2 = 10.09$). This finding indicates that the decision to participate and farm skill improvement are influenced by unobserved factors. The selection bias occurs in the agricultural extension service model, therefore, the effect estimation of AC agricultural extension services on farm skill improvement must account for the selection bias using the ESR model.

Table 6.7 reports that the probability of adopting improved farm technologies and practices for AC service participants is influenced by low quality farm products and household wealth. Firstly, the probability of the adoption for participants is significantly and positively influenced by low quality of farm products at the 1% level for both AC credit and agricultural extension service models. This result indicates that participants in AC credit and agricultural extension services who grow not good quality farm products and so they seek advice and technology to improve their crops. Households who access loans and farm technologies supported by ACs are able to afford farm technologies and improved inputs therefore they are more likely to apply improved farm technologies and inputs. This shows that ACs support farmers in adopting improved farm technologies and inputs by providing credit and agricultural extension services.

The probability of participants adopting improved farm technologies and farm practices significantly increases with savings at the 5% and credit use at the 1% level for the AC agricultural extension service model, (see Table 6.7). This finding on credit use is in line with Ma (2016), Tiwari et al. (2008), and Wossen et al.'s (2017) findings, where credit accessibility assists households to unlock liquidity constraint which ultimately means they can invest in improved technologies. Similarly, savings provide liquidity; thus, households with savings are more likely to apply updated technologies and inputs. These results imply that households who have savings are more likely to invest in improved technologies and inputs to increase their production (Ma, 2016).

Owning farm assets has a significantly negative effect on the probability of adopting improved farm technologies and practices at the 1% level, for both participants and non-participants in the AC agricultural extension service model. This result suggests that farmers who own agricultural tools (for example, a reaping hook, plough, sprayer, digger, or harrow) and machinery (a four-wheel tractor, hand tractor, trailer, tiller, or irrigation pump) are more likely to use traditional farming methods. This finding is consistent with Chatarat, Attavanich, Mahasuweerachai, Thampanichvong, and Chenphuengpaw (2019) and Ratanavararak et al.'s (2019) findings. Most of Thai farmers possess farm tools and machineries, however, they used traditional farming methods. For example, over 65% of agricultural household grows single crop (Chenphuengpaw, Chatarat, Attavanich, & Sangimnet,

2019). They use heavy agrochemicals, such as fertilizer, pesticide, and herbicide, and barely apply modern farm technology and innovation to increase their production (Ratanavararak et al., 2019). The authors indicate that farmers' decision to use the traditional method can be explained by three factors: farmers' behaviour, technology access, and inefficient government policy (Chatarat et al., 2019; Chenphuengpaw et al., 2019; Ratanavararak et al., 2019). Over 50% of labour in Thailand agricultural sector are elderly. The elderly farmers are risk averse with limited learning capability. As a result, they do not have incentives to learn and adopt new farm knowledge and technologies. Secondly, small farmers, who are the majority of farmers in Thailand, cannot access modern technologies because it is costly. Lastly, the government policies do not encourage farmers to apply modern technologies. Thai government has focused on financial aid schemes such as crop price intervention and financial subsidy programs. These schemes can assist farmers in short-term but do not improve their agricultural production.

Effect of AC Services on Household Health

Tables 6.8 and 6.9 present the results of AC service participation on household health. This study measures health effect in terms of the affordability of medical treatment and improved healthcare access. While Table 6.8 shows the effects of AC credit and marketing participation on a household's affordability in accessing health care facilities, Table 6.9 shows the effects of AC credit and marketing participation on household improvement in health access. Health access improvement is a dummy variable. Household health access equals 1 if households have more ability to access medical treatment, 0 otherwise.

Table 6.8 shows that only the correlation coefficients (ρ) for non-participants in AC marketing services is statistically significant at the 1% level. The negative correlation, which indicates a positive selection bias, suggests that households who have greater health affordability than the average level are less likely to participate in AC marketing services. The presence of a selection bias for the AC marketing model is confirmed by the Wald test results for joint independence of the three equations. The Wald test result ($\chi^2 = 9.06$) is statistically significant at the 1% level, indicating that the error terms of participation and health affordability equations in the AC marketing service model are related. Ignoring the selection bias in the model leads to biased results. Therefore, we must use the ESR model to evaluate the effects of AC marketing service to mitigate the selection bias. In terms of the AC credit model, the results indicate the absence of a selection bias since both correlation coefficients and the Wald test for joint independence of the three equations ($\chi^2 = 0.35$) is not significantly different from zero.

Table 6.7 Effects of AC Credit and AC Marketing Service Participation on Adoption of Improved Farm Technologies and Practices using the Endogenous Switching Probit Model (ESP)

Variables	AC Credit			AC Agricultural Extension		
	Participation (Y/N)	Adoption of Improved Farm Skills		Participation (Y/N)	Adoption of Improved Farm Skills	
		Participants	Non- Participants		Participants	Non- Participants
<i>Individual Characteristics</i>						
Age_Yr	0.084** (0.036)	-0.074 (0.070)	0.101** (0.050)	0.079** (0.038)	-0.062 (0.072)	0.133*** (0.044)
Age_Sq	-0.0008** (0.0003)	0.0006 (0.0006)	-0.0009* (0.0005)	-0.0007** (0.0003)	0.0006 (0.0007)	-0.001*** (0.0004)
Edu_Yr	-0.023 (0.017)	0.0260 (0.026)	0.030 (0.025)	0.002 (0.017)	0.014 (0.024)	0.069** (0.029)
Sex	-0.149 (0.109)	-0.183 (0.163)	0.072 (0.162)	-0.249** (0.107)	-0.014 (0.152)	-0.126 (0.155)
Paddy	-0.377** (0.171)			-0.449*** (0.154)		
Orchard	0.015 (0.249)			-0.541*** (0.209)		
Cash_Crop	0.506*** (0.161)			0.434*** (0.152)		
<i>Household Characteristics</i>						
Farm_Mem	0.009 (0.064)	0.047 (0.084)	-0.161* (0.089)	0.085 (0.055)	0.076 (0.081)	-0.097 (0.097)
Farm_Si	0.012** (0.005)	-0.0006 (0.003)	-0.005 (0.004)	0.001 (0.005)	-0.0002 (0.003)	0.004 (0.003)
Farm_Sq	-5.36e-05** (2.73e-05)			-1.17e-05 (2.45e-05)		
Sav	-0.234** (0.103)	0.233 (0.149)	0.062 (0.156)	-0.026 (0.102)	0.330** (0.141)	-0.012 (0.151)
Farm_Ass	-0.286** (0.130)			-0.162 (0.107)	-0.568*** (0.164)	-0.471*** (0.172)
Land	-0.308* (0.178)	0.078 (0.231)	0.008 (0.247)	0.160 (0.178)	0.057 (0.236)	-0.049 (0.223)
Inc_PU	-0.093 (0.128)	-0.248 (0.183)	0.154 (0.186)	-0.073 (0.131)	-0.341* (0.183)	0.208 (0.187)
Off_Farm		-0.034 (0.177)	-0.183 (0.182)	0.138 (0.119)	-0.038 (0.174)	-0.160 (0.178)
Oth_Loan, Cre_Use	-2.54e-07 (2.85e-07)			0.977*** (0.120)	0.963*** (0.215)	0.405** (0.166)
Ext_Acc	0.782*** (0.148)					
<i>Household Perceptions of Risk</i>						
Pro_Risk	-0.026 (0.070)			0.057 (0.068)		
Mkt_Risk	-0.043 (0.0748)			0.0001 (0.068)		
Fin_Risk	0.171** (0.075)			0.179*** (0.060)		

Table 6.7 Effects of AC Credit and AC Marketing Service Participation on Adoption of Improved Farm Technologies and Practices using Endogenous Switching Probit Model (ESP) (cont.)

Variables	AC Credit			AC Agricultural Extension		
	Participation (Y/N)	Adoption of Improved Farm Skills		Participation (Y/N)	Adoption of Improved Farm Skills	
		Participants	Non- Participants		Participants	Non- Participants
Weather		0.021 (0.081)	-0.069 (0.094)		0.008 (0.085)	-0.081 (0.082)
Pest		0.058 (0.067)	0.117 (0.090)		0.030 (0.066)	0.095 (0.080)
Soil		0.065 (0.060)	0.129* (0.072)		-0.019 (0.061)	0.261*** (0.072)
Irr_Acc		-0.056 (0.146)	-0.019 (0.163)		-0.043 (0.141)	0.056 (0.156)
Qual		0.186*** (0.064)	-0.094 (0.070)		0.164*** (0.059)	-0.069 (0.067)
Geographic Factors						
Dis_Town	0.020*** (0.005)					
Dist_N	0.402*** (0.135)	0.278 (0.181)	-0.406** (0.204)	0.418*** (0.133)	0.181 (0.183)	-0.296 (0.200)
Dist_S	-0.110 (0.142)	-0.100 (0.193)	-0.294 (0.214)	0.112 (0.139)	-0.225 (0.180)	-0.059 (0.212)
AC_Rela (IV)	1.067*** (0.153)			0.961*** (0.150)		
AC_Vill				0.794*** (0.149)		
Constant	-3.429*** (1.080)	1.922 (1.977)	-1.852 (1.440)	-4.389*** (1.121)	1.051 (2.128)	-3.091** (1.382)
Athro		-0.393 (0.400)	-0.104 (0.297)		0.606** (0.278)	0.833** (0.360)
Rho		-0.374 (0.344)	-0.104 (0.294)		0.541** (0.196)	0.682** (0.192)
Wald Test of Indep. Eqns.			0.98			10.09***
Observations			850			850
Wald Chi ²			227.54***			216.39***

Note: 1. *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.
2. Robust Standard Errors are given in brackets
3. Computed by the authors using 2017 survey data.

Regarding health access improvement, the selection bias does not occur in the AC credit and marketing models. Table 6.9 shows that the correlation coefficients for both AC credit and marketing service models are not significant. Furthermore, the Wald test for joint independence of the three equations for the AC credit model ($\chi^2 = 1.48$) and for the AC marketing service model ($\chi^2 = 0.49$) are not statistically significant. These results suggest that unobserved factors do not influence a household's decision to participate in AC credit and marketing services nor do they affect the outcome (health access improvement) for both participants and non-participants.

Regarding determinants of health effect, household health affordability for AC service participants has a strong correlation with age, paddy farming, farm size, savings, land ownership, and financial risk (see Table 6.8). Based on individual characteristics, age significantly and positively influences household health affordability at the 1% level for the AC credit model, and at the 5% level for the AC marketing service model. This result implies that older AC participants have more ability to pay for healthcare when they need it. One possible reason is higher income and less consumption. According to section 6.3.2, among the AC credit and marketing service participants, the older participants obtain higher household income due to more experience in farm production and AC participation. In addition, households will spend less for food and children education when they get old.

Paddy farming exhibits a significant and negative impact with household health affordability at the 5% level for the AC credit model. This result implies that AC borrowers who are rice farmers are less able to afford healthcare compared to those who grow other crops. One possible reason is rice farmers earn less income than other farmers. The results of the T-test using survey data provides evidence that the average household income of rice farmers is significantly lower than those of other farmers at the 1% level ($t = 4.6590$). On average, rice farmers earn around 227,500 baht a year, while other farmers earn approximately 508,343 baht a year (see Appendix C.2).

Regarding household characteristics, coefficients of farm size are positively significant on health affordability for every household group at the 1% level. This result suggests that household affordability to health access increases with farm size (see Table 6.8). Farm size refers to farm production scale. The larger the farm, the more income a household earns: thus, their ability to pay for healthcare. For other wealth indicators, savings are positively significant for health affordability at the 5% level for AC credit model, but not significant for the AC marketing service model. However, financial risk is significant and negative for both participants and non-participants in the AC credit and marketing models at the 1% level. Similarly, land ownership significantly and negatively affects participants in AC credit at the 1% level, and AC marketing services at the 10% level. The effects of wealth may be explained by liquidity. Households with higher savings have more liquidity; thus they are more able to afford healthcare compared to those who are less wealth. Similarly, financial risk is

negatively related to health affordability, suggesting that households with higher financial risks are less able to afford healthcare because of high liquidity constraints. However, households which possess greater land/farm assets need to spend money on maintaining them, thus, they have less money left for healthcare.

Health accessibility improvement for AC service participants is significantly determined by the household head's education and land ownership at the 1% level (see Table 6.9). Household head's education positively influences improved household access to health facilities for every household group. This result is consistent with Doan's (2011) finding that Vietnamese households with greater education levels and credit access spend more on healthcare. For land ownership, the relationship between land ownership and health access improvement is in line with the effect of landholding on health affordability, which is a negative relationship.

Summary of AC Service Participation on Household Social Welfare

Tables 6.10 and 6.11 present the estimates for the average treatment effects of AC service participation on household education and health outcomes. The results indicate four important points. Firstly, both AC credit and marketing services do not improve children's education; educational expenditure or school enrolment (see Tables 6.10-6.11). In terms of educational expenditure, both AC credit and marketing services do not increase households' educational expenditure for both treated (ATT) and untreated (ATU) groups (see Table 6.10). Regarding treated samples, the findings show that ATT is not statistically significant for the AC credit model, indicating that AC credit borrowers do not spend more on their children's education. However, the ATT of AC marketing services is significantly negative at the 1% level, implying that households trading with ACs tend to spend less on their children by 18.13%. These results suggest that AC credit and trading with ACs do not lead to greater spending on children's education. These findings reflect the fact that Thai schools are publicly funded. Children aged between 6 to 15 years can attend public schools at no cost (Constitution Drafting Commission, 2007). The government has established the free education to make it more accessible for Thai children and to reduce parents' costs. This support covers tuition fees, textbooks, stationery, and uniforms (Ministry of Education Thailand, 2010). Due to government assistance, households do not spend much on their children's education. Therefore, as the models show, educational expense does not differ among the households. The results are consistent with the findings of Coleman (1999) in Thailand and Setboonsarng and Parpiev (2008) in Pakistan, indicating that credit borrowing is not significant in terms of school expenses. Similarly, for untreated samples, both AC credit and marketing services have a significant and negative effects on household education expenditure at the 1% level. This result suggests that non-participants would have spent less for their children education if they had borrowed from AC credit (0.72%) and trade with ACs

(4.14%). These results indicate that AC services do not increase household educational expenditure for both participant and non-participants.

Table 6.8 Effects of AC Credit and AC Marketing Service Participation on Health Affordability using the Endogenous Switching Regression Model (ESR)

Variables	AC Credit			AC Marketing Services		
	Participation (Y/N)	Health Affordability		Participation (Y/N)	Health Affordability	
		Participants	Non- Participants		Participants	Non- Participants
Individual Characteristics						
IgAge	-0.062 (0.289)	2.489*** (0.921)	0.748 (1.186)	0.067 (0.282)	2.835** (1.160)	1.406 (1.004)
IgEdu	-0.115 (0.127)	0.594 (0.485)	-0.149 (0.561)	0.044 (0.142)	0.595 (0.672)	0.079 (0.462)
Paddy	-0.464*** (0.171)	-1.036** (0.455)	-0.995 (0.828)	-0.118 (0.153)	-0.510 (0.534)	-1.102* (0.601)
Orchard	-0.269 (0.239)	-1.245 (1.101)	1.594 (1.042)	-0.201 (0.235)	-0.657 (1.381)	0.763 (0.972)
Cash_Crop	0.323* (0.165)	0.144 (0.601)	-0.761 (0.861)	-0.026 (0.146)	-0.087 (0.763)	-0.253 (0.576)
Household Characteristics						
IgHHmem	-0.230* (0.133)	0.587 (0.427)	0.806 (0.585)	-0.202 (0.128)	0.164 (0.586)	1.153** (0.450)
Dep_Rat	-0.116 (0.081)	0.308 (0.211)	-0.612 (0.377)	0.113 (0.071)	0.121 (0.270)	-0.285 (0.303)
IgFarm_Size	0.231*** (0.074)	1.865*** (0.265)	1.50*** (0.342)	0.415*** (0.071)	1.844*** (0.333)	1.30*** (0.285)
Sav	-0.084 (0.113)	0.707** (0.358)	1.233** (0.511)	0.224** (0.107)	0.541 (0.480)	1.107*** (0.405)
Farm_Ass	-0.176 (0.117)	-0.457 (0.400)	-0.352 (0.567)	0.131 (0.113)	0.023 (0.488)	-0.893** (0.434)
Land	-0.391** (0.180)	-1.184*** (0.401)	-0.520 (0.889)	-0.047 (0.167)	-1.094* (0.583)	-0.908 (0.597)
Commer	0.081 (0.126)	0.866 (1.222)	1.191** (0.555)	-0.090 (0.135)	1.735 (1.317)	1.172** (0.508)
Oth_Loan, Cre_Use	-1.78e-07 (2.97e-07)			0.406*** (0.132)	0.448 (0.698)	-0.098 (0.479)
Ext_Acc	0.799*** (0.123)			0.392*** (0.118)		
Household Perceptions of Risk						
Pro_Risk	-0.059 (0.075)	-0.081 (0.210)	-0.211 (0.346)	-0.086 (0.070)	0.030 (0.271)	-0.300 (0.257)
Mkt_Risk	-0.010 (0.078)	0.027 (0.287)	-0.291 (0.429)	0.105 (0.074)	0.093 (0.326)	-0.348 (0.353)
Fin_Risk	0.225*** (0.063)	-0.744*** (0.204)	-1.108*** (0.311)	0.014 (0.061)	-0.710*** (0.246)	-0.945*** (0.242)

Table 6.8 Effects of AC Credit and AC Marketing Service Participation on Health Affordability using the Endogenous Switching Regression Model (ESR) (Cont.)

Variables	AC Credit			AC Marketing Services		
	Participation (Y/N)	Health Affordability		Participation (Y/N)	Health Affordability	
Geographic Factors						
IgDis	0.292*** (0.056)					
Dist_N	0.353** (0.144)	0.358 (0.516)	-0.458 (0.633)	-0.209 (0.133)	-0.247 (0.712)	0.125 (0.515)
Dist_S	-0.167 (0.151)	-0.786 (0.497)	-0.450 (0.647)	-0.349*** (0.134)	-0.372 (0.565)	-0.672 (0.550)
AC_Rela	0.941*** (0.150)			0.699*** (0.163)		
AC_Vill	0.581*** (0.177)			0.526*** (0.159)		
Comm_Att	0.249*** (0.033)			0.196*** (0.033)		
Constant	-2.329* (1.398)	-3.403 (4.220)	6.604 (5.825)	-3.581** (1.412)	-6.564 (5.393)	3.688 (4.875)
Sigma		3.662*** (0.047)	4.637*** (0.048)		3.352*** (0.077)	4.659*** (0.097)
Rho		0.017 (0.116)	-0.088 (0.167)		0.169 (0.131)	-0.404*** (0.134)
Wald Test of Indep. Eqns. (Chi2)			0.30	9.06***		
Observations			839	839		
Wald Chi2			113.24***	79.85***		

Note: 1. *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.
2. Robust Standard Errors are given in brackets
3. Computed by the authors using 2017 survey data.

Table 6.9 Effects of AC Credit and AC Marketing Service Participation on Health Access Improvement using the Endogenous Switching Probit Model (ESP)

Variables	AC Credit			AC Marketing Services		
	Participation (Y/N)	Health Access Improvement		Participation (Y/N)	Health Access Improvement	
		Participants	Non- Participants		Participants	Non- Participants
Individual Characteristics						
Age_Yr	-0.003 (0.006)	0.007 (0.008)	0.001 (0.008)	0.003 (0.005)	0.007 (0.010)	0.007 (0.006)
Edu_Yr	-0.030* (0.017)	0.076*** (0.022)	0.072*** (0.024)	0.011 (0.017)	0.096*** (0.027)	0.063*** (0.019)
Paddy	-0.459*** (0.170)	0.396* (0.223)	0.538* (0.300)	-0.092 (0.154)	0.352 (0.244)	0.566*** (0.215)
Orchard	-0.219 (0.246)	1.030*** (0.323)	0.552** (0.271)	0.032 (0.172)	0.169 (0.254)	0.236 (0.210)
Cash_Crop	0.482*** (0.168)	0.215 (0.209)	0.223 (0.256)	-0.220 (0.228)	0.189 (0.436)	1.109*** (0.246)
Household Characteristics						
HH_Mem	-0.046 (0.036)	0.063 (0.045)	0.019 (0.059)	-0.039 (0.034)	0.011 (0.067)	0.083* (0.048)
Dep_Rat	-0.145* (0.080)	0.054 (0.094)	-0.109 (0.108)	0.090 (0.071)	0.086 (0.121)	-0.061 (0.096)
Farm_Si	0.013** (0.005)	-0.006* (0.003)	0.002 (0.003)	0.018*** (0.005)	-0.005 (0.004)	-0.002 (0.005)
Farm_Sq	-5.77e-05** (2.70e-05)			-6.96e-05** (3.06e-05)		
Inc_PU		0.082 (0.178)	0.611*** (0.165)		0.068 (0.230)	0.406*** (0.140)
Farm_Ass	-0.182 (0.121)			0.188 (0.136)		
Land	-0.318* (0.173)	-0.545*** (0.195)	0.053 (0.249)	-0.038 (0.236)		
Oth_Loan, Cre_Use	-8.34e-08 (2.93e-07)	3.97e-07 (5.97e-07)	-3.09e-07 (5.47e-07)	0.386*** (0.127)	0.392 (0.304)	0.010 (0.249)
Ext_Acc	0.745*** (0.141)			0.342* (0.200)		
Commer				-0.065 (0.182)		
Household Perceptions of Risk						
Pro_Risk	-0.056 (0.098)			-0.051 (0.153)		
Mkt_Risk	-0.016 (0.088)			0.0991 (0.120)		
Fin_Risk	0.239*** (0.065)			0.012 (0.075)		
Geographic Factors						
Dis_Town	0.019*** (0.005)	0.003 (0.006)	-0.017* (0.009)			
Dist_N	0.416*** (0.144)	-0.212 (0.210)	-0.401* (0.213)	-0.170 (0.133)	-0.440 (0.277)	-0.145 (0.172)

Table 6.9 Effects of AC Credit and AC Marketing Service Participation on Health Access Improvement using the Endogenous Switching Probit Model (ESP) (Cont.)

Variables	AC Credit			AC Marketing Services		
	Participation (Y/N)	Health Access Improvement		Participation (Y/N)	Health Access Improvement	
		Participants	Non-Participants		Participants	Non-Participants
Dist_S	-0.187 (0.156) (0.155)	-0.291 (0.198)	0.247 (0.191)	-0.332* (0.172) (0.176)	-0.313 (0.246)	0.237 (0.201)
AC_Vill	0.597*** (0.191)			0.586*** (0.214)		
Comm_Att	0.259*** (0.033)			0.183*** (0.037)		
Constant	-1.942*** (0.617)	-1.687*** (0.595)	-2.118*** (0.702)	-2.678*** (0.707)	-2.381** (1.033)	-2.604*** (0.593)
Athro		0.297 (0.413)	-0.146 (0.240)		0.261 (0.636)	-0.022 (0.846)
Rho		0.289 (0.379)	-0.145 (0.235)		0.256 (0.595)	-0.022 (0.846)
Wald Test of Indep. Eqns. (Chi2)			1.48			0.49
Observations			850			839
Wald Chi2			252.28***			147.90***

Note: 1. *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.
2. Robust Standard Errors are given in brackets
3. Computed by the authors using 2017 survey data.

Regarding the effect on school enrolment, AC credit and marketing services do not improve school enrolment rates. Table 6.11 reveals that AC credit and AC marketing participation have significantly negative effects on school enrolment for participants at the 1% level. This result indicates that households who join AC services are less likely to send all their school-aged children to school (ATT). This finding is consistent with Shimamura and Lastarria-Cornhiel's (2010) study, who reports that agricultural credit participation in Malawi decreases school attendance rates. The authors explain that when households borrow credit, they are more involved in income generating activities. As a result, children are employed to work at home or on the farm. This situation is similar with our survey data, showing that young children (those under school age) engage in household or farm work and start to work full-time when they reach 15 years old. If households borrow more money, their school-aged children are more likely to work. Therefore, there is less probability of sending every school-aged child to school.

Table 6.10 Effects of AC Service Participation on Household Social Welfare

Outcomes	AC Services	Group	Mean Outcome		Average Treatment Effect	T-Value	Change (%)
			Actual	Counterfactual			
Educational Expenditure	Credit	Participants	9.813	9.844	ATT = -0.031	-1.142	-0.32
		Non-Participants	9.751	9.681	ATU = -0.070	-2.282**	-0.72
	Marketing Services				TH = 0.039		
		Participants	9.730	11.885	ATT = -2.154	-68.297***	-18.13
		Non-Participants	9.781	9.376	ATU = -0.405	-17.379***	-4.14
					TH = -1.749		
Health Affordability	Credit	Participants	10.987	9.661	ATT = 1.326	20.501***	13.72
		Non-Participants	9.785	10.052	ATU = 0.267	3.574***	2.73
	Marketing Services				TH = 1.059		
		Participants	11.437	8.031	ATT = 3.406	49.767***	42.41
		Non-Participants	9.946	9.530	ATU = -0.416	-8.188***	-4.18
					TH = 3.822		

Note: 1. *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.
2. Computed by the authors using 2017 survey data.
3. TH stands for transition heterogeneity

Table 6.11 Effects of AC Service Participation on Household Social Welfare

School Enrolment	Average Treatment Effect	T-Value
Credit	ATT = -0.064	-7.709***
	ATU = -0.094	-11.027***
	TH = 0.03	
Marketing Services	ATT = -0.115	-10.010***
	ATU = 0.073	8.432***
	TH = -0.188	
Adoption of Improved Farm Skill	Average Treatment Effect	T-Value
Credit	ATT = 0.111	12.770***
	ATU = 0.125	16.499***
	TH = -0.014	
Agricultural Extension Services	ATT = -0.124	-17.914***
	ATU = -0.260	-20.154***
	TH = 0.136	
Health Access Improvement	Average Treatment Effect	T-Value
Credit	ATT = 0.110	17.363***
	ATU = -0.031	-4.619***
	TH = 0.141	
Marketing Services	ATT = 0.042	5.906***
	ATU = -0.096	-19.486***
	TH = 0.138	

Note: 1. *, **, and *** indicate significance level at 10%, 5%, and 1% levels, respectively.
2. Computed by the authors using 2017 survey data.
3. TH stands for transition heterogeneity

Secondly, in terms of informal education for adults, AC credit plays an important role in the adoption of improved farm practices and technologies for both participants and non-participants (see Table 6.11). AC credit participation significantly increases the adoption of improved farm technologies and skills for participants at the 1% level. This result indicates that households who borrow AC credit are more likely to implement improved farm technologies and practices (see Table 6.11). Similar results are obtained for non-participants in AC credit who would have been more likely to adopt updated farm technologies and practices if they had borrowed money from ACs (ATU).

In contrast, participation in agricultural extension services offered by ACs does not improve a household's adoption of farm technologies and practices. The result reveals that the probability of farm technology adoption significantly decreases with participation in AC agricultural extension services at the 1% level for both treated (ATT) and untreated (ATU) samples (see Table 6.11). These results suggest that ACs do not work well in farm production development. This may be explained by several reasons. Most farmers prefer to use traditional methods for farming because they confront high production costs and debts (Chanthakhananurak, Thaipakdee, & Seeniang, 2015; Chatarat et al., 2018). Hence, they do not have enough capital to invest in new technologies and farm inputs.

Moreover, approximately 49% of the respondents are over 55 years of age and 34% of the respondents are over 60 years old. Since most of the households are elderly, they are reluctant to learn new farming methods. Finally, AC agricultural extension projects are frequently short term. Time constraints associated with AC projects obstruct efficient household implementation (Pleehachinda, 2003). These findings contradict Calkins and Ngo (2010), Francesconi and Ruben (2007), and Getnet and Anullo's (2012) results, showing that AC agricultural extension services improve farmers' production by motivating members to apply improved seed and use updated farm implements.

Thirdly, both AC credit and marketing participation have positive effects on the improvement of household health access. In this study, health effect is measured using health affordability and access to health treatment when households are sick. Tables 6.10 and 6.11 show that both AC credit and marketing services enhance a household's health affordability and access to health treatments. The results show that an increase in health affordability for AC credit and marketing service participants is significantly different from zero at the 1% level. This result suggests that households who borrow AC credit and trade with ACs have greater access health facilities by 13.72% and 42.41%, respectively (see Table 6.10). In short, participation in AC credit and marketing services increase household and farm incomes; eventually, participants have a greater capacity to afford health treatment.

ACs should extend their credit to non-AC members in order to improve their household health affordability. Non-participants' health affordability would significantly increase (by 2.73% at the 1% level) if they had borrowed from ACs (see Table 6.10). However, AC marketing services cannot improve health affordability for households who do not participate. AC marketing services have a significant and negative effect on non-participants' health affordability at the 1% level, suggesting that non-participants would have had been even less likely to afford medical treatment (by 4.18%) if they had traded with ACs.

In terms of health access, AC credit and marketing services have a significantly positive effect on households' health access at the 1% level. This result implies that households who borrow money and trade with ACs are more likely to improve their accessibility to medical treatment (see Table 6.11). The findings are consistent with Setboonsarng and Parpiev's (2008) study, which concludes that microcredit access in Pakistan significantly increases the probability of participants seeking medical treatment and households' funds to pay for medical treatment. For untreated respondents, both AC credit and marketing service significantly decrease households' access medical treatment, at the 1% level. This finding indicates that households who do not join AC services would have had less probability of medical access if they had participated in AC services. This implies that health access for non-participants will not improve if they participate in AC credit and marketing services.

Finally, the TH of health outcomes are positive for both the AC credit and marketing service models (see Table 6.10 for TH of health affordability and Table 6.11 for TH of health access improvement). These results indicate that actual participants would have obtained health benefits more than the non-participants in AC credit and marketing services. However, the TH of AC credit is negative for the implementation of improved farm technologies and practices (see Table 6.11). The AC credit participants would have gained less benefit from AC credit borrowing than non-participants if they had participated. This finding suggests that AC credit will work more effectively in increasing the adoption of improved technologies and practices, if they extend credit to non-members.

6.4 Chapter Summary

This chapter evaluates the effects of participation in AC credit and non-credit support services on household welfare using cross sectional data from 2017. The effects of AC service participation on household welfare are evaluated using two models (ESR and ESP) to control for selection bias. The results of both models can be condensed into four points. The selection bias is present in the effects of AC credit participation on farm income and household consumption, indicating that there are unobservable factors influencing a household's decision to participate in AC credit and outcomes: farm income and consumption. Similarly, the effects of AC marketing service participation on household income, farm income, and health affordability incur a selection bias, suggesting that a household's decision to participate in AC marketing services and outcomes (household income, farm income, and health affordability) are influenced by unobserved factors. The selection bias also takes place in the effect of AC agricultural extension service participation on the adoption of improved farm technologies and practices. The ESR and ESP models are used to mitigate the selection bias arising from observed and unobserved factors.

AC credit and AC marketing services play important roles in improving household economic welfare. AC credit exhibits significant positive effects on household and farm income, and household consumption for both participants and non-participants. Households who access AC credit have more money to invest in income generation activities; as a result, they will earn more income and are able to consume more goods and services. Regarding AC marketing services, participation in these services increases household and farm income but not consumption. Trading using AC marketing services increases household and farm income for participants, and would have a similar effect for non-participants if they chose to use these services.

Interestingly, AC credit and marketing services do not improve children's education in terms of educational expenses and school enrolment rates. Since the Thai government subsidises compulsory education for children aged 6 to 15, educational spending is minimal and differs very little between households. Moreover, borrowing AC credit decreases the probability of sending every school-aged

children to school. More borrowing in AC credit makes parents more involve in income generation so children tend to work to help their parents.

Only AC credit considerably increases the adoption of improved farm technologies and practices, which indicates the role of AC credit in farm production development. However, using AC agricultural extension services does not improve farm production since it cannot encourage participants to adopt improved farm technologies and practices. Under health effects, households' health affordability and health access improve when they borrow money from, or trade with, ACs. Households have more income when they participate in AC credit and marketing services, thus, they have money to access medical treatment when they are sick.

The TH for household income, farm income, consumption, and health affordability are positive for both AC credit and marketing service models. These results provide evidence that ACs offer services to the right customers since the current participants obtain higher benefits than non-participants if they had chosen to participate. However, the TH of the adoption of improved farm technologies and practices is negative for the AC credit model. The negative TH indicates that the effect of AC credit would have been higher for non-participants if they had chosen to borrow money. This finding means that if non-participating households had chosen to borrow AC loan, they would have been more likely to invest in the improved farm technologies and practices than the actual participants. This finding indicates that ACs can increase their effectiveness in farm production development by extending credit to non-member households.

Effect comparison between AC credit and marketing services indicates that AC credit is less effective in improving household economic welfare than AC marketing services. Similarly, AC marketing services are more effective in improving social welfare in terms of household health affordability and healthcare access improvement.

Chapter 7

Conclusion

This chapter summarizes the study's findings. Section 7.1 refreshes the background of the research, as well as the questions, objectives and methodology. Section 7.2 presents the study's major findings. While section 7.3 discusses the implications of the study's findings, section 7.4 provides the limitations and directions for future research.

7.1 Research Background and Methodology

Thailand faces significant challenges regarding poverty. Although the national poverty rate has reduced substantially over the last three decades, from 67% in 1986 to 7.1% in 2015, more than 6.7 million Thais remain vulnerable to falling back into poverty (World Bank, 2018). Most of the poor live in rural areas (Lewis et al., 2013). Rural households remain impoverished while confronting constraints such as limited access to resources, low educational outcomes, insufficient financial capital and inability to access financial and product markets (Mojo et al., 2017).

Credit and non-credit support services (marketing and agricultural extension services) play a crucial role in assisting Thai rural households to escape poverty. Credit access allows households to unlock liquidity constraints to enable greater investment in economic activities and smooth their consumption (Reed, 2011). Non-credit support services assist farm households to improve their productivity and access input and output markets by reducing transaction costs, raising bargaining power, and obtaining market information (Ma, 2016). As a result, rural populations are able to improve their productivity, asset formation, and income. Increase in income would enhance the poor's opportunities to attain improved nutrition and access essential services.

Even though Thai ACs provide credit and non-credit support programs for rural households, poverty statistics for this group remains high. One possible cause impeding AC's effectiveness in improving rural households' welfare is low participation rates. Another possible reason is that AC members do not use integrated services available to them. Strong member participation in AC services is a crucial factor affecting their performances and members' benefits (Ruete, 2014; Williams, 2007). If there is low member participation or trade, ACs will not have sufficient capital to survive and thus their ability to help will be curtailed. Low member participation in Thai ACs should be critically analysed to make them more effective in alleviating poverty.

Our study examines how ACs help Thai rural households to improve their welfare. It investigates how ACs can improve their services in order to meet members' needs and increase their effectiveness in

household welfare enhancement. There are four research objectives in this study: (i) to review ACs' role in improving Thai rural household welfare; (ii) to investigate the determinants of rural households' participations in AC credit and non-credit support services; (iii) to evaluate the effects of AC credit provisions on Thai rural households' economic and social welfare; and (iv) to examine the effects of AC non-credit support programs on Thai rural households' economic and social welfare.

The data for our study was collected from rural households in the Nakhonratchasima province, in the Northeast of Thailand, using a structured questionnaire. Nakhonratchasima was selected as the study area since it had the greatest number of AC members in Thailand: 305,627 members and 99 ACs as of December 2018 (Cooperative Promotion Department, 2019). Nakhonratchasima is divided into six areas based on the provincial development plan and policy. The study used a two-stage stratified sampling technique to select the rural household sample and obtain the best representatives from the study population. The first stage involved selecting one district from each group that had the greatest number of AC members. Pakchong, Pakthongchai, Phimai, Nonsung, Dankhunthot, and Buayai were selected as the study areas. In the second stage, households were selected from each district. The sample from each district was calculated using the disproportionate stratified random sampling method. In total 851 households were interviewed, of which 560 (66%) were AC members, and 291 (34%) were non-AC members.

Our study applied the probit model to estimate the probability of AC credit and agricultural extension service participation. Regarding AC services, the Heckman selection model was used to examine the determinants influencing AC service participation and participation level. Our study considered three AC services: credit, input and output marketing services. Thus, there were three Heckman selection models used in our study. The Heckman selection model for each AC service consisted of both a participation equation and participation level equation. These systems of equations were estimated using the Heckman two-stage approach. To obtain consistent coefficients, our study used household's expected benefits from AC services as a selection instrument variable in the Heckman selection model. This variable was chosen because it affects a household's decision to participate in AC services, but it does not affect their level of participation.

To answer research objectives three and four, our study applied the ESR and the ESP to evaluate the effects of AC service participation on households' economic and social welfare. As the ESR model is suitable for continuous outcomes, we used it to evaluate the AC effect on household income, farm income, household consumption, educational expense, and health affordability. In contrast, the ESP model is only capable of dealing with binaries and thus was used to determine outcomes for school enrolment, adoption of improved farm technologies and practices, and health access improvement. Both models used the FIML method to estimate participation and outcome equations

simultaneously. For consistency, our study used AC neighbour membership (AC_Rela) and the presence of AC in a household's village (AC_Vill) as instrument variables in the ESR and ESP models. These variables influence a household's decision to participate in AC services, but they do not affect their welfare.

The sampled households (see section 4.4) in our study are representative of Thailand rural household in general. According to Thailand National Survey data, most of Thai farmers are elderly. At the country level, 46% of Thai farmers are older than 55 years old (The agricultural census, 2013). The national survey data is consistent with our survey data, which showed that 50% of our sampled households are over 55 years old. A significant proportion of farmers have attended primary education (64% of all Thai farmers and 72% of our sampled households). The majority of farmers owned agricultural land less than 40 rais (around 87% of all Thai farmers and 83% of our sampled households). The average farmers' farm size at the country level is about 20 rais and for our sampled households it is about 25 rais. Most farmers owned land (65% of all Thai farmers and 70% of our sampled respondents). Over 60% of Thai farmers and our sampled respondents grow rice. Moreover, around 42% of Thai farmers and 43% of our sampled respondents can access to water resources for farm production. Although, the survey of this study covers only one province, the surveyed data is reflective of the national survey. The Nakhonratchasima province is Thailand's largest agricultural land areas. Significantly, the total area of farmland in this province is 6.6 million rais (National Statistic Office, 2013). Since the Nakhonratchasima province shares borders with the Central and Eastern parts of Thailand, agricultural land of this province is diverse (Siamwalla et al., 1990; Netayarak, 1998). With a variety of geographical landscapes (river plains, highlands, and mountainous areas), farmers in the Nakhonratchasima province grow a wide variety of crops including the primary crops similar to farmers in other provinces of Thailand. In addition, our demographic results reflect the national survey demographic data, thus the results of this study can be generalised at country level.

7.2 Major Findings

Our study provides detailed information about how ACs can increase their membership numbers and utilization of their service. ACs can use these findings to improve their services provision, which in turn will improve household welfare. The current study examines two issues. Firstly, which factors influence a household's decision to participate in AC and AC services? Secondly, how do AC services impact household welfare? The findings are summarized below.

7.2.1 Determinants of AC Service Participation

Our study examines factors relating to household participation in AC and AC services in Thailand. The probit model results confirm prior studies' findings (see Bernard et al., 2008; Bernard & Spielmen, 2009; Ito et al., 2012; Mojo et al., 2017), which indicate that the probability of participation in ACs is influenced by household characteristics, household perceptions of agricultural risks, perception of AC benefits, and geographical factors. First, crop type has a strong and positive influence on AC participation. Cash crop farmers have a higher probability of becoming AC members compared to farmers who do not grow cash crops. In contrast, paddy farmers are less likely to participate in ACs. Farm size results reveal that medium-sized farmers are more likely to join ACs compared to those who have small or large farms. Moreover, credit use and access to agricultural extension services increase the probability of AC participation. Farmers using credit are more likely to join ACs, indicating that farmers participate in AC when they face liquidity constraints and need to borrow money to invest in farm production (Fischer & Qaim, 2012; Wossen et al., 2017). Farmers who access to agricultural extension services are more likely to participate in ACs. One possible explanation is that they perform better by following ACs' quality standards. This finding is consistent with Abebaw and Haile (2013) and Ma and Abdulai's (2016) results.

The household risk and perceptions of AC benefit results reveal that households choose to participate in AC because they need credit. Our findings indicate that farmers with higher financial risks, satisfaction with AC management, or who believe that ACs will assist them to access credit and market information, are more likely to join ACs since they want to obtain loans and buy farm inputs on credit (Zheng et al., 2011). However, production risks decrease farmers' motivations to participate in ACs. Farmers may not believe that ACs can reduce farm production difficulties or improve their production levels. The results show that farmers with higher farm production risks are less likely to participate in ACs. This result is consistent with Ferto and Szabo (2002) and Zhang et al.'s (2017) findings which reveal that farmers with low quality products are less likely to participate in ACs since their products do not meet the required standards. Moreover, relatives have the greatest impact on AC participation, which is in line with Ito et al. (2012), Ma and Abdulai (2016), and Mensah et al.'s (2012) findings. This result suggests that social network is a dominant factor influencing a household's decision to participate in ACs.

The probability of participation in AC credit is positively influenced by the following factors; farm size, access to agricultural extension services, distance to the nearest market, and neighbour's attitude toward AC credit participation. In contrast, it is negatively affected by household-head education and farm asset ownership. The findings show that household-heads with higher educational attainment are less likely to borrow money from ACs. This result is consistent with previous studies, which

suggest that less-educated individuals are more likely to borrow from informal credit sources (see for example, Duy et al., 2012; Fongthong & Suriya, 2014; Khoi et al., 2013; Sebopetji & Belete, 2009; Zeller, 1994). ACs are important credit sources for poorer households who cannot access formal loans. Households who have less farm capital have a higher probability of AC credit accessibility. Although ACs are the main credit sources for low-income households, they cannot help the poor access credit. ACs will only offer credit to poor households if they can demonstrate that they are able to repay their loans. These findings are confirmed by the positive relationship between farm size and the probability of participation in AC credit services, which is in line with Khoi et al. (2013) and Nguyen's (2007) work. In addition, middle-class farmers have the greatest probability of borrowing money from ACs. Social networks play an important role in AC credit participation in terms of sharing AC information. Prior research has indicated that households who obtain information about ACs from relatives or neighbours are more likely to participate in AC credit (Duy et al., 2012; Khoi et al., 2013).

Regarding loan size, our study found that farmers growing cash crops are more likely to borrow money compared to those growing other crops. Farmers with larger farms will borrow greater amounts of money compared to farmers with smaller farms, since they need more financial capital to invest in production. This finding is consistent with Coleman (2006), Duong and Izumida (2002), Duy et al. (2012), Khoi et al. (2013), and Nguyen's (2007) findings. In terms of farm risks, farmers who confront higher financial risks are given smaller loans. Farm production and market risks do not impact AC loan size. Interestingly, our results show that AC credit attributes strongly dominate loan size. AC share, loan duration, and using property as collateral have positive effects on loan size, which is consistent with previous studies (for example, see Khoi et al., 2013, Oloade & Olagunju, 2013). Our findings show that ACs in different districts grant members different loan amounts depending on their available funding.

Our findings on factors which affect household participation in AC input marketing services are consistent with prior studies (See Alene et al., 2008; Ma & Abdulai, 2016; Muthyalu, 2013; Winter-Nelson & Temu, 2005). Member decisions to purchase farm inputs through ACs are significantly influenced by farm size, perception of benefits, and district, technology accessibility, and residing in the same village with ACs. Mid-sized farmers are the most likely to access AC marketing services. Further, experience and information of AC input marketing benefits play important roles in a household's decision to purchase inputs from ACs. Farmers who have stronger belief that ACs will assist them to access good quality inputs at reasonable prices are more likely to purchase farm inputs from ACs. Farmers accessing farm technologies and residing in a village with an AC have a higher likelihood of purchasing farm inputs from ACs. This finding indicates that ACs provide advanced technologies and inputs to households for farm production improvement. Households living in the area where an AC is located tend to buy farm input from AC since it does not cost them extra money

to travel to AC market (Winter-Nelson & Temu, 2005). In terms of input expenditure, our results show that AC members' input expenses are significantly correlated with farm size, farm income, production risk, and payment method. As expected, farm size and farm income have positive effects on AC input expense. AC members who confront high farm production risks spend less on farm inputs. Moreover, AC input expenses increase considerably with input purchase on credit.

Household probability of selling farm products to ACs is positively influenced by paddy farm, farm size, AC output market benefits, and the southern districts. It is negatively affected by financial risks and distance to ACs. Rice farmers with larger farms are more likely to participate in AC output marketing services than farmers who do not grow rice. The highest probability of selling farm products to ACs is the middle-sized farmers. This result is the same as Fischer and Qaim (2012, 2014), Mensah et al. (2012), and Zhang et al.'s (2017) findings. Household perceptions of output market access has the strongest impact on selling their products to AC. In contrast, households with higher financial risks are less likely to sell to AC output markets. As the distance from farm to ACs increases, the probability of participation decreases due to travel costs. The further away farmers live, the greater the transaction costs they incur and the less profit they make (Chagwiza et al., 2016; Muthyalu, 2013). In terms of farm product amount sold to ACs, it is influenced by orchard farm, farm size, ratio of sale to yields, AC output price, and selling through alternative channels. Members sell less fruits and vegetables to ACs compared to other crops. There are no specific ACs that deal with fruits and vegetables in the area, since the Nakhonratchasima province is not suited to growing fruits and vegetables. Farm size and the portion of sales are positive and significantly impact the farm product amount sold to ACs. These results support the view that the more households trade through ACs, the greater the benefits they gain (Fischer & Qaim, 2014). Interestingly, the level of marketing participation significantly decreases with output price offered by ACs. When output market prices are higher, ACs which have limited financial resources purchase less farm products.

Participation in AC agricultural extension services is significantly related to household characteristics (land ownership, irrigation accessibility, and off-farm work), household perceptions of production risks and AC satisfaction, the district, and AC location. Households who own land and are employed off the farm are more likely to participate in AC agricultural extension services. Farmers holding land gain benefits from adopting technologies and farm practices associated with agricultural extension services (Atsan et al., 2009; Elias et al., 2013). Off-farm work provides an additional income source for the household. Increased income enables households to purchase equipment and apply for updated farm technologies or practices offered through agricultural extension services (Ma, 2016). However, farmers who have access to irrigation systems are less likely to participate in these services compared to those who do not. Farmers who access irrigation systems do not lack of water for farm production; thus, they may be not interested in farm improvements when compared to farms with

no irrigation systems. This finding contradicts Egziabher et al.'s (2011) work. Their result shows that access to irrigation does not have a significant impact on participation in agricultural extension services in Ethiopia because the participants and non-participants are not significantly different in irrigation access. Moreover, our results suggest that household experiences of AC operations are important factors in a household's decision to join agricultural extension services. Households who have higher production risks and who are satisfied with AC performance are more likely to participate in agricultural extension services. Households who live close to ACs find it easier to access farm support services and have lower travel costs than those who live further away (Egziabher et al., 2011).

7.2.2 Effects of Agricultural Cooperative Services on Household Welfare

Our study evaluates the effects of AC service participation on household economic and social welfare. Regarding economic welfare, all AC services play important roles in improving household economic welfare. AC credit participation significantly improves household and farm incomes, and consumption for both treated (ATT) and untreated (ATU) groups. Participation in AC marketing services play an important role in raising household and farm incomes but not household consumption. AC marketing services increase AC members' farm income as they provide low cost farm inputs and offer reasonable prices for farm products (Bernard et al., 2008; Calkins & Ngo, 2010; Fischer & Qaim, 2012; Ito et al., 2012; Wollni & Zeller, 2007). Moreover, ACs allow members to purchase farm inputs on credit. This allows farmers to unlock liquidity constraints for their productions. In contrast, members' consumption does not increase whether they trade with ACs or not.

The effects of AC credit participation on household and farm incomes are less than those of AC marketing services. This result indicates that trading through AC marketing channels provides households with greater economic benefits than what they receive through borrowing AC credit. In terms of transition heterogeneity, the average effect of participation in AC services is greater for actual participants (ATT) compared to non-participants, had they chosen to participate (ATU). This finding suggests that ACs are meeting the needs of their target group since actual participants obtain greater benefits from participation in AC credit and marketing services than non-participants.

Social effect covers education and health effects. Effects of AC service participation on educational outcomes can be summarised in two points. Firstly, participation in AC credit and marketing services do not raise children's education rates, educational expenditure and school enrolment. This finding is not surprising given that Thai schools are publicly funded. Secondly, in terms of informal education for adults, only AC credit increases the adoption of improved farm technologies and practices for participants. In contrast, participation in agricultural extension services does not improve

participants' adoption of improved farm technologies and practices. This result shows that ACs are not effective in farm production development. One possible explanation is most farmers confront high production costs and levels of debts, so they often prefer to use traditional methods of farming (Chanthakhananurak et al., 2015). Moreover, most household head are older with low levels of education. It is difficult for them to learn new knowledge. Finally, agricultural extension projects tend to be short term or temporary. The nature of these projects means that households cannot effectively implement them (Pleehachinda, 2003).

Both AC credit and marketing services enhance a household's health affordability and health treatment accessibility. Participation in AC credit and marketing services increase household and farm incomes; eventually, participants have a greater capability to afford health treatment. This result is consistent with Nghiem et al.'s (2007) finding, which suggest that ACs directly improve household income and increase in income encourages households to spend more on health care. However, both AC credit and marketing service do not improve medical treatment accessibility for non-AC participants (if they had chosen to participate in AC services). This finding indicates that non-AC participants made the right decision not to borrow credit or trade through ACs as they would not have obtained any benefits. The transition heterogeneity (TH) of health outcomes are positive for both AC credit and marketing service participation. Actual participants obtain more health benefits than non-participants from AC credit and marketing services. These results indicate that ACs are effective in improving targeted households' health status in terms of health affordability and healthcare access.

7.3 Implications

The findings have several implications for academics and AC practitioners.

7.3.1 Academic Implications

Our results provide evidence to support the presence of selection bias in AC services participation. Our study used the ESR and ESP models to control selection bias. The ESR model results indicate the presence of a selection bias in the AC credit model in terms of the effects on farm income and household consumption. Similarly, a selection bias is also present in the AC marketing service model and impacts on household income, farm income, and health affordability. A selection bias is also evident in the AC agricultural extension service model and relates to the adoption of improved farm technologies and practices. These results suggest that there are unobservable factors, which influence a household's decision to participate in AC services and their outcomes (household and farm income, consumption, health affordability, and farm technology and practice adoption). Thus,

scholars evaluating AC effects on household welfare should consider unobservable factors to ensure an unbiased result.

The Heckman selection model results clearly identify the influence of household perceptions of agricultural risks and AC expected benefits on participation in AC credit and non-credit support services. Financial risks have a positive effect on AC participation, while production risks have a negative effect. These findings support previous studies which argue that production and sale difficulties, as well as fund scarcity, affect households' decision to participate (Hoken, 2016; Hoken & Su, 2015; Ito et al., 2012; Zheng et al., 2011). Furthermore, our study found that AC performance and households' belief in expected benefits highly influence households' decisions to participate in ACs and AC services. Our study provides empirical knowledge related to household's decision to participate in credit and non-credit support services that other researchers can use to examine determinants of household participation in ACs and their services. Our study suggests that further research in this field should include household perceptions of agricultural risks and AC expected benefits in the model.

7.3.2 Policy Implications

Our findings provide the evidence, not only of the factors, which influence household participating in ACs and AC services, but also the effective of AC implementation. The findings indicate that several factors affect households' decisions to participate in AC credit and non-credit support services. Our empirical results also reveal that ACs improve household economics and social welfare (household and farm income, consumption, health access, and adoption of improved farm technologies and practices). Therefore, these findings have different implications for different groups (households, ACs and the government).

Household Recommendations

Improving AC and AC service participation should start from the household themselves. They should reduce the agricultural risks since households' agricultural risks significantly influence their decisions to participate in ACs and AC services. Our finding shows that high production risks are a significant obstacle for farmers who wish to join ACs. This may be because farmers do not believe that ACs are able to reduce farm production difficulties or improve their production levels, hence farmers with high production risk have no incentive to participate in ACs. Furthermore, high production risks cause low quality products, that is, products do not meet AC standards (Ferto & Szabo, 2002; Zhang et al., 2017). In short, household with high production risks are less likely to participate in ACs. In addition to production risks, households who have higher financial risks have higher demands for credit. However, they are risky customers and often granted lower credit amounts. Moreover, they are less likely to sell their products to ACs because of liquidity constraints.

However, it is difficult for farmers, particularly small farmers, to reduce their agricultural risks by themselves. They need support from the government and ACs. One practical way that households can reduce their agricultural risks and improve their agricultural production capacity is participating in agricultural development projects launched by the Thai government. In 2016, the Thai government launched 15 major projects to improve farmers' production levels across the country. Their objectives are to reduce production costs, to improve agricultural production, and to enhance market access. The government projects include a collaborative farming project, a learning center for agricultural production improvement, an agricultural commodity bank, and a debt repayment suspension project. The first two projects can decrease agricultural risks in a short period of time. These projects aim to effectively solve common farming problems and increase farmers' bargaining power using an area-based approach. These projects operate in every province across country. They bring together farmers whose farms are in the same area/province. Farmers who live in the same village confront similar constraints such as soil fertility, water scarcity, weather uncertainty, and agricultural pests. These projects not only improve agricultural production capacity but also enable the creation of agricultural networks. The government generates a network, which covers the relevant stakeholders in supply chain such as input suppliers, farmers, and output users. The network supports project participants from the start of the production process right through to market access; the aim is to reduce production costs and enhance marketing accessibility. The last two projects can reduce household financial risks. The Thai government established the agricultural input bank and debt repayment suspension projects to help farmers reduce their debts. The agricultural commodity bank provides farm inputs such as seed and fertilizers in advance, thus it assists farmers to access farm inputs. This implies that even if the farmers confront financial constraints, they can access the necessary resources to ensure they have a crop/crops to grow. The debt repayment suspension project assists indebted farmers to become debt free. The project specialist designs reimbursement and business plans for indebted farmers. Therefore, participating in these government projects will enable households to reduce their agricultural production, market, and financial risks.

However, these projects have not been entirely successful in reaching the targeted households. Households are not interested in joining the government projects because these projects do not meet their needs (Poapongsakorn et al., 2015). The government lacks updated information on farmers' problems and constraints. In short, they do not understand the real causes of farmer poverty (Poapongsakorn et al., 2015). Many of the government schemes have been designed using a top-down approach without surveying the target participants', therefore they do not meet the farmers' needs. Furthermore, in the past, the government has focused on financial assistance schemes, such as loans with low interest rate, rice pledging schemes, and financial aid for farmers

(Poapongsakorn et al., 2015). These schemes only improve farmers' well-being in the short-term. Financial aid programs do not improve farmers' production and risk management abilities. Therefore, they are not effective in the long-term. As a result of the top-down nature of these programs, farmers prefer financial aid schemes to those of production development because they obtain money without any effort. In short, most Thai farmers wish to participate in the financial assistance schemes. Lastly, the projects are complicated for farmers. In order to participate in these projects farmers must complete a variety of tasks, which can be quite challenging for some. For example, participants must analyse their problems, design production and business plans, identify inputs and technologies, and record income and expenditure. This means that only farmers with farm management skills can participate in such programs. Therefore, most Thai farmers are not able to participate. One way to increase participation rates in these projects is to include ACs.

Agricultural Cooperative Recommendations

ACs should encourage farmers to participate in government projects, which result in farmers' agricultural risk reduction. ACs should act as farmers' counsellors. ACs should transfer government project information to farmers and encourage them to participate. They should assist and educate the farmers in choosing the most appropriate and profitable projects. It is difficult for farmers to understand the terms and conditions of the projects, since many of them are old and have low levels of education. Furthermore, these projects are new to them. They are hesitant as to whether the projects will succeed or not. AC officers can provide members with project information and suggest which projects are suitable for their specific problems. However, encouraging members to participate in government projects will only succeed if AC officers have a clear understanding of the aims and benefits of each projects.

Although linking up with government projects does not provide direct benefits to ACs, participation in these projects help households to improve their production capacities and reduce agricultural risks. ACs also gain indirect advantages, such as resolving AC fund scarcity and increasing ACs' potential members. If ACs are able to train their members through government projects, then they will not spend their limited budgets generating training courses. Farm production development projects have financial backing from the Thai government. Moreover, the government projects can efficiently solve farmers' problems since they are supervised, monitored, and followed up by farm specialists. Farmers participating in these projects can gain knowledge and learn skills which will enable them to overcome their own production problems. Moreover, farmers who graduate from government projects will become good AC members. When AC members graduate from government projects, they have higher levels of farm education, production and risk management. They will become potential customers who are ready to do business with ACs.

To improve poor households' welfare, ACs should offer their services to poor households but only if they meet certain criteria. Our findings show that middle-class households are the main beneficiaries of ACs credit and market accessibility services. This indicates that the poor still experience barriers to access AC credit and non-credit support services. Poor households tend to have small scale production and less productive assets; thus, they have lower demands for credit. Although they have high credit demands, particularly for business expansion, they are less likely to be granted loans. They present too great a risk because they have low production capacities and would have difficulties to repay the loans (Duy et al., 2012; Li et al., 2011a). These findings confirm previous studies which reveal that the poor cannot generate enough income due to lack of capital (Bernard & Spielman, 2009; Chagwiza et al., 2016; Fischer and Qaim, 2012; Wollni & Zeller, 2007). Therefore, improving farmers' production capacities should be the first priority; this should be a pre-requisite for accessing AC services. In practice, ACs should only allow farmers to become members once they have completed training on production capacity development. One AC condition could be asking the farmers to participate in government projects. Participating in government projects enable the poor to access resources for farm production. These projects provide credit for cash and farm inputs, farm technology and machines, and output markets for selling their production. Moreover, participants are supervised by farm specialists to solve their agricultural problems and design farm production and business plans. Training in these projects can help participants improve their production capacities and farm skills, and eventually increase their income. Therefore, these conditions can protect ACs from losses when they extend their services to the poor.

The results show that information sharing is a crucial component to encourage households to participate in ACs. Households who receive information about ACs from their relatives or neighbours are more likely to participate in ACs. Our survey result indicates that most non-AC members have limited information about AC functions and benefits. If ACs wish to increase their participation rates or expand their customer base, they must increase their marketing efforts and provide information about their successes and expected benefits to farmers. There are several ways information can be transmitted. For example, ACs should develop and update their websites. Website should contain AC information, updated market information, and agricultural knowledge. ACs should present the information in simple formats such as infographics and videos to attract targeted customers who have low levels of education. If ACs have limited funds to generate website or individuals cannot access the internet, ACs should provide information about their performance directly to the villages, using posters and seminars.

Travel costs are associated with a lack of participation in AC marketing services. Households who live close to ACs are more likely to trade with ACs due to low travel costs and easy accessibility. ACs should consider reducing farmers' travel costs as this would encourage members to use their

marketing services. Developing an AC network may reduce production and transportation costs and increase the group's bargaining power. ACs should promote both horizontal and vertical networks. A horizontal network of ACs (for example, rice ACs, rubber ACs, and cassava ACs) would reduce production costs, increase bargaining power, and improve production (Dardak, 2015). Our study finds that the rice cooperative network is a crucial network in increasing members' incomes. The strong collaboration among rice ACs increase bargaining power with input suppliers and output users. For example, a rice cooperative network can help all members in the network to develop their rice quality; in short, they will increase their product value. Collaboration among ACs (through an AC network) can reduce members' cost of production and provide members with a higher price for their farm products, which ultimately leads to higher incomes (Patrawart & Sriurai, 2010).

Likewise, a vertical network, with other stakeholders in the supply chain, can reduce production costs and market volatility (Dardak, 2015; Zhong, Zhang, Jia, & Bilman, 2018). ACs should contract with input wholesalers for fertilizers, seeds, and agrichemical supplies. Input contracts would potentially lead to lower input prices and transportation costs. Since wholesalers may have several distributors in the cities, AC members should be able to pick up inputs from the closest distributor. Besides, input contracts can decrease the risk of input price fluctuations. Similarly, to increase output market accessibility and control output market fluctuations, AC networks should engage in forward contracts to sell products with their product users such as factories, hotels, supermarkets, and other ACs. A vertical network is an effective tool for managing market risks as ACs can determine the price and amount of inputs and products that their members need (Ma, 2016). However, AC network creation needs support from the national federation and provincial cooperatives.

ACs can improve their members' economic welfare and increase service participation rates through redesigning their service policies. Our results show that AC service characteristics influence participation levels. AC shares, loan duration, and using property as collateral, have positive effects on loan, while purchasing on credit highly influences households to purchase inputs from ACs. These results suggest that AC innovation plays an important role in motivating members to use AC services. To increase participation levels, ACs should redesign their lending and trading policies to make them more flexible and suitable for household needs. Based on our study results, small farmers who borrow money may not be able to repay the entire loan and interest by maturity date. Agricultural production is characterised by uncertainty (natural and market risks); farmers may obtain less yield and/or income than they are expected. If they have to pay back their entire loans and interest, they may need to borrow money from informal lenders. As a result, they are become more indebted and trapped in a cycle of debt. Since AC's primary aim is to improve household economic welfare, they should assist households with access to credit services that do not trap them into a debt cycle. ACs should offer flexible repayments schemes to encourage borrowers to pay back their loans. For

example, ACs should allow borrowers to pay back the loan in small amounts and save some money for next planting season. This lending policy assist borrowers to unlock liquidity constraints and to escape the debt cycle. Moreover, ACs should motivate borrowers to repay their loans. Loan refinancing with lower interest rates may be used for good borrowers.

To increase marketing service participation, ACs should provide innovative ways of marketing their members' products. To increase input purchases, the government should support ACs to buy farm inputs on credit from the agricultural input bank or private companies under the government projects. Most rural households consist of small farmers who lack financial capital and farm assets. They lack access to credit services. At present, ACs allow members to purchase farm input on credit. However, this service is limited due to AC fund scarcity. If ACs can obtain trade credit agreements with input producers, then this would enable them to pass on these savings to their members. However, trade credit agreements need government support. The government already has agreements with input suppliers for their agricultural projects thus the government could help ACs to access input producers.

Trade among cooperatives should be promoted to increase AC sales. The Cooperative Promotion Department should encourage cooperatives to do business together. Trade refers to both trade within ACs and with other cooperatives. In practice, ACs should form contracts with other ACs and cooperatives. For example, rice ACs should sell their products to other ACs which grow other crops. Agricultural cooperatives are able to sell their products to consumer cooperatives, service cooperatives, and credit union. These ACs and cooperatives can buy rice cheaper and sell it to their members. Trade among cooperatives can increase AC sale volumes. When ACs have greater sales, they can buy more products from their own members.

The results of AC effects show that AC credit and marketing service are important for improving household income. Our study found that AC marketing services are more effective in increasing income than AC credit. Since ACs confront fund limitations, it is difficult to increase the numbers of individuals borrowing credit. It is for this reason that ACs should concentrate on improving the effectiveness of marketing services. In the context of trade liberalization, ACs compete with agribusiness enterprises. To increase their competitiveness, ACs should create business partnerships with private company. These partnerships may help ACs extend output markets and improve their products through the transfer of farm knowledge and technology. ACs may find partners through attending the Commerce Chamber project established by the government. Working with the Commerce Chamber can improve AC management and output marketing services. They can provide ACs with advice about how to add value to their products.

The ESP model result shows that ACs have failed to improve members' farm production level. Participation in AC agricultural extension services cannot improve farm production since they cannot encourage participants to implement improved farm technologies and practices. One possible explanation is that members lack financial capital to afford new farm technologies. To overcome members' financial capital scarcity, ACs should create training services to develop their members' production skills which increase their income. Income generating skill training should involve both on-farm and off-farm activities which focus on income generation. Courses could include on-farm product processing to add value to products. These skills are essential to increase farmers' capabilities and increase their income. When farmers have more income, they can afford new technologies; in turn, they benefit financially from the adoption of such technologies.

Government Recommendations

The findings of this study provide some recommendations to improve the AC participation rate and efficiency. The government policies significantly influence functionality of ACs. The success or failure of ACs relies on the government support. The government can increase the number of members participating by improving farmers' education about ACs. The findings show that households' perception of the expected benefits obtained from ACs and information access positively influence farmers to participate in ACs and AC services. This implies that farmers gaining knowledge, information, and experience in AC are likely to become AC members and use their services. Therefore, appropriate policies to improve (or access) AC knowledge to targeted participants is necessary to increase AC membership. The government can use a host of channels to transmit the information, for example advertising through village meeting, local state offices, radio, internet, and social media. Furthermore, the government should update the information on ACs to ensure farmers have access and understand the information. The information content should consist of the AC concept and objectives, function, benefits and costs of participating in ACs, and successful performance of ACs.

A lack of credit access is a barrier for farmers to invest in agricultural technologies. Our study results indicate that credit use positively influence households' decision to join in agricultural extension services provided by ACs and the effect of AC credit on adoption of improved farm technologies and practice is positive. These results suggest that households who access credit exhibit a higher probability to participate in the agricultural extension services and apply the updated technologies in their farming. To increase the effectiveness of AC agricultural extension services, the government should promote the role of ACs as training institutions. The training institution aims are to improve and train farming methods and increase technology adoption. The government should provide technological and financial support to the training institutions. ACs should work together with the provincial agricultural extension department to research and develop suitable farming technologies

and methods for farmers. ACs have information about farmers' agricultural production, finance and various constraints. The research collaboration between state organizations and ACs enables the agricultural extension department officers to understand the root cause of problems and obtain current information about local farmers. As a result, the agricultural extension department officers are able to identify solutions based on farmers' problems and needs and generate business plans appropriate for the farmers. To ensure that farmers obtain financial capital, the government should offer credit for farming investment with low interest rate to farmers through ACs. Moreover, ACs can involve private companies as partnerships in the enhancing the capacity of the training institutions. The partnerships will share capital, technology, and skill with ACs. Because of the expertise in research and development of private companies, the training institutions enhance their ability to develop new technologies and enable farmers to access new farming technologies.

7.4 Limitations and Future Research

Our study has several limitations. Firstly, our study focused on multiple agricultural cooperatives. This included ACs with different characteristics; for example, ACs for rice versus cash crop farmers, small versus large ACs, success versus failure ACs, and those which have networks and those without. These characteristics influence AC success to generate benefits for members (Verhofstadt & Maertens, 2014). However, the study results do not capture the effects across different ACs (the heterogeneous impact). For example, our study does not compare the effects of ACs for rice farmers with cash crop growers, the effects of small ACs versus large ACs, or the effects of ACs with good horizontal and vertical networks versus those without established network. It is important to understand what type of ACs succeed in improving household welfare. Future studies could examine the effects of ACs on household welfare by considering the heterogeneous nature of ACs.

Our study estimated the effects of AC services on household welfare using the ESR and ESP models. The ATE results reveal the magnitude of effects of AC service use on household welfare. However, the results cannot explain how ATE varies with household characteristics (the heterogeneous treatment effect). The heterogeneous treatment effects reveal who are most likely to obtain benefits from using AC services. Heterogeneous treatment effect analysis is important because it enables ACs to improve their service effectiveness; ACs can apply the heterogeneous effect results to identify the right customers. The heterogeneous treatment effect evaluation is a tool for improving AC effectiveness.

Finally, our AC effect results for children's education capture enrolment and schooling expenditures for primary and middle education, both of which are compulsory. Since the Thai government subsidizes compulsory education, the schooling expenditures and enrolment ratio between AC members and non-AC members does not differ greatly. In short, our results show that AC service

participation does not improve children's education. Future studies might consider whether AC participation impacts on enrolment rates for higher education: in short, whether parents pay for their children to attend high school or university. As higher education is optional, the Thai government does not offer subsidies. Unlike primary school, which is free, households must pay fees for high school and university. Therefore, it would be interesting to identify the effect of AC service participation on children's (higher) education without the effects of the government subsidy.

References

- Abate, G. T., Francesconi, G. N., & Getnet, K. (2014). Impact of agricultural cooperatives on smallholders' technical efficiency: Empirical evidence from Ethiopia. *Annals of Public and Cooperative Economics*, 85(2), 257-286.
- Abebaw, D., & Haile, M. G. (2013). The impact of cooperatives on agricultural technology adoption: Empirical evidence from Ethiopia. *Food policy*, 38, 82-91.
- Aditto, S. (2011). *Risk analysis of smallholder farmers in central and Northeast Thailand* (Doctoral dissertation, Lincoln University).
- Ahmad, A. R. (2006, September). Agricultural cooperatives in Malaysia: Innovations and opportunities in the process of transition towards the 21st century model. In *2006 FFTCNACF International seminar on agricultural cooperatives in Asia: Innovations and Opportunities in the 21st century, Seoul, Korea* (pp. 11-15).
- Ahmed, M. H., & Mesfin, H. M. (2017). The impact of agricultural cooperatives membership on the wellbeing of smallholder farmers: Empirical evidence from eastern Ethiopia. *Agricultural and Food Economics*, 5(1), 6.
- Akerele, E. O., & Akanni, K. A. (2014). Effects of cooperative credit on farmers' socio-economic welfare in Yewa south local government area, Ogun State. *Finance, Economics and Applied Research Journal*, 1(2), 1-13.
- Alene, A. D., & Manyong, V. M. (2007). The effects of education on agricultural productivity under traditional and improved technology in Northern Nigeria: An endogenous switching regression analysis. *Empirical economics*, 32(1), 141-159.
- Alene, A. D., Manyong, V. M., Omany, G., Mignouna, H. D., Bokanga, M., & Odhiambo, G. (2008). Smallholder market participation under transactions costs: Maize supply and fertilizer demand in Kenya. *Food policy*, 33(4), 318-328.
- Anuchitworawong, C. (2007). Credit access and poverty reduction. *TDRI Quarterly Review*, 22(4), 15-21.
- Anyiro, C. O., & Oriaku, B. N. (2011). Access to and investment of formal microcredit by smallholder farmers in Abia State, Nigeria. A case study of Absu Micro Finance Bank, Uturu. *The Journal of Agricultural Sciences*, 6(2), 69-76.

- Araullo, D. B. (2006, September). Agricultural cooperatives in the Philippines. In *seminar. Agricultural Cooperatives in Asia: Innovation and opportunities in the 21st Century*.
- Arthur, L. H., & van Kooten, G. C. (1985). The theory of the farm household: An application to Saskatchewan. *Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie*, 33(1), 23-35.
- Ashakul, B., & Chandoevlwit, W. (2007). The impact assessment of village funds on poverty. In How to solve poverty problem- competition, subsidy, or welfare: Proceedings of Academic Conference of Chaipattana Foundation and Thailand Development Research Institute, *Chonburi 10-11 November 2007*. Thailand.
- Atieno, R. (2001). Formal and informal institutions' lending policies and access to credit by small-scale enterprises in Kenya: An empirical assessment (Vol. 111). *Nairobi: African Economic Research Consortium*.
- Atsan, T., Isik, H. B., Yavuz, F., & Yurttas, Z. (2009). Factors affecting agricultural extension services in Northeast Anatolia Region. *African Journal of Agricultural Research*, 4(4), 305-310.
- Autta, S. (2014). *Collective action of farm product: Success of MaeChan Cooperative*. Retrieved from <https://soclaimon.wordpress.com/2015/01/03/รวมกลุ่มจัดการผลผลิตเง/>.
- Awotide, B. A., Abdoulaye, T., Alene, A., & Manyong, V. M. (2015). Impact of access to credit on agricultural productivity: Evidence from smallholder cassava farmers in Nigeria. In *International Conference of Agricultural Economists* (pp. 1–34). Milan, Italy.
- Bank of Thailand. (2013). *Financial access survey of Thai households 2013*. Retrieved from <https://www.bot.or.th/English/FinancialInstitutions/Highlights/Pages/2013%20Financial%20Access%20Survey%20Final.pdf>
- Bank of Thailand. (2015). *Agricultural product report in 2014 and trend for 2015*. Retrieved from https://www.bot.or.th/Thai/MonetaryPolicy/NorthEastern/Doclib_CommodityYearly/Yearly-2557_Trend-2558_final.pdf
- Bank of Thailand. (2016). *Thailand's macroeconomic indicators*. Retrieved from <https://www.bot.or.th/Thai/Statistics/Indicators/Pages/default.aspx>
- Banking with the Poor Network, & Foundation for Development Cooperation. (2010). *Microfinance industry report Thailand 2010*. Queensland, Australia.

- Barrett, C. B. (2008). Smallholder market participation: Concepts and evidence from eastern and southern Africa. *Food policy*, 33(4), 299-317.
- Baumrungwong, C. (2001). *Cooperative development in Thailand: Past present and development: (Final report for The Thailand Research Fund)*. Bangkok, Thailand.
- Bernard, T., & Spielman, D. J. (2009). Reaching the rural poor through rural producer organizations? A study of agricultural marketing cooperatives in Ethiopia. *Food policy*, 34(1), 60-69.
- Bernard, T., Taffesse, A. S., & Gabre-Madhin, E. (2008). Impact of cooperatives on smallholders' commercialization behavior: Evidence from Ethiopia. *Agricultural Economics*, 39(2), 147-161.
- Bernard, T., Spielman, D. J., Taffesse, A. S., & Gabre-Madhin, E. Z. (2010). *Cooperatives for staple crop marketing: Evidence from Ethiopia (IFPRI discussion papers 164)*. Washington, DC.
- Bernasek, A. (2003). Banking on social change: Grameen Bank lending to women. *International Journal of Politics, Culture, and Society*, 16(3), 369-385.
- Bester, H. (1987). The role of collateral in credit markets with imperfect information. *European Economic Review*, 31(4), 887-899.
- Birchall, J., & Simmons, R. (2009). Co-operatives and poverty reduction. *Manchester: Co-op College*.
- Boonperm, J., Haughton, J., & Khandker, S. R. (2013). Does the village fund matter in Thailand? Evaluating the impact on incomes and spending. *Journal of Asian Economics*, 25, 3-16.
- Bunthong, T. (2014). *The effect of access to credit sufficiently on Thai agricultural household productivity* (Master thesis, Thammasat University).
- Bureau of Agricultural Economic Research. (2015). *Business development of agricultural cooperatives to smart farmers: (Office of Agricultural Economic Report)*. Bangkok, Thailand.
- Bushway, S., Johnson, B. D., & Slocum, L. A. (2007). Is the magic still there? The use of the Heckman two-step correction for selection bias in criminology. *Journal of quantitative criminology*, 23(2), 151-178.
- Calkins, P., & Ngo, A. T. (2010). The impacts of farmer cooperatives on the well-being of cocoa producing villages in Côte d'Ivoire and Ghana. *Canadian Journal of Development Studies/Revue canadienne d'études du développement*, 30(3-4), 535-563.

- Center for Social Innovation and Participation (2012). *Moving Thailand forward: Way for cooperative development*. Retrieved from <http://v-reform.org/wp-content/uploads/2012/07/แนวทางการขับเคลื่อนปฏิรูประบบสหกรณ์ไทย-edited1.pdf>
- Cerdán-Infantes, P., Maffioli, A., & Ubfal, D. (2008). The impact of agricultural extension services: The case of grape production in Argentina. *Office of Evaluation and Oversight (OVE). Inter-American Development Bank. Washington, DC*.
- Chainuvati, C., & Athipanan, W. (2001). *Crop diversification in Thailand*. Retrieved from <http://www.fao.org/3/x6906e/x6906e0c.htm>
- Chagwiza, C., Muradian, R., & Ruben, R. (2016). Cooperative membership and dairy performance among smallholders in Ethiopia. *Food Policy*, 59, 165-173.
- Chan, Y. S., & Kanatas, G. (1985). Asymmetric valuations and the role of collateral in loan agreements. *Journal of money, credit and banking*, 17(1), 84-95.
- Chanchengpanich, J. (2015). *Toward solving the agricultural cooperatives in Thailand*. Retrieved from <http://library2.parliament.go.th/ebook/content-issue/2558/hi2558-041.pdf>
- Chandoevrit, W., & Ashakul, B. (2008). The impact of the village fund on rural households. *TDR/Quarterly Review*, 23(2), 9-16.
- Chandra, A. (2003). *Is the convergence of the racial wage gap illusory?* (No. w9476). National Bureau of Economic Research.
- Chanthakhananurak, R., Thaipakdee, S., & Seeniang, P. (2015). Economic factors of farmers effecting on agricultural development in land reform area: Lam Nang Rong sub-district, Non Din Daeng district, Buriram province. *Veridian E-Journal*, 8(3).
- Charitonenko, S., & Campion, A. (2003). Expanding commercial microfinance in rural areas: Constraints and opportunities. In *Rural finance an international conference on best practices* (pp. 1–20).
- Chatarat, S., Attavanich, W., Mahasuweerachai, P., Thampanichvong, K., & Chenphuengpaw, J. (2019). *Thai agricultural outlook: How to achieve sustainable development?*. Retrieved from https://www.bot.or.th/Thai/ResearchAndPublications/DocLib_/Article_26Sep2019.pdf
- Chatarat, S., Attavanich, W., & Sangimnet, B. (2018). *Thai agricultural outlook: Structure and changes of Thai agriculture sector*. Retrieved from https://www.pier.or.th/?post_type=abridged&p=5580

- Chavez Hertig, M. E. (2008). *100 Million Jobs: The contribution of cooperatives to employment creation*. Retrieved from <http://www.ilo.org/Search5/search.do?searchLanguage=en&searchWhat=100+million+jobs>
- Chenphuengpaw, J., Attavanich, W., Chatarat, S., & Sangimnet, B. (2019). *Dynamic of Thai agriculture: Agricultural households' risk and return*. Retrieved from https://www.pier.or.th/wp-content/uploads/2019/06/aBRIDGEd_2019_014.pdf
- Chiengkul, W. (2015). *Solutions of problems: Problems and solutions for cooperatives development in Thailand*. Retrieved from https://pr.prd.go.th/ubonratchathani/ewt_news.php?nid=3529&filename=index
- Chowdhury, A. (2009). *Microfinance as a poverty reduction tool: A critical assessment*. UN.
- Coleman, B. E. (1999). The impact of group lending in Northeast Thailand. *Journal of development economics*, 60(1), 105-141.
- Coleman, B. E. (2006). Microfinance in Northeast Thailand: Who benefits and how much?. *World development*, 34(9), 1612-1638.
- Community Development Department. (2014). *Thai living standard report*. Bangkok, Thailand: Ministry of Interior.
- Constitution Drafting Commission. (2007). *Thailand constitutional law*. Retrieved from https://ilaw.or.th/sites/default/files/%202559_0.pdf
- Co-operative Academic Institute. (2015). *Agricultural cooperatives and role in food security of nation*. Retrieved from http://www.cai.ku.ac.th/cai/index.php?option=com_content&view=article&id=179&Itemid=10
- Cooperative Auditing Department. (2014). *Statistic of cooperatives' performance and financial information for 10 years (2005-2014)*. Retrieved from http://www.cad.go.th/ewtadmin/ewt/statistic/download/statistic_2y5y10y/57/10y/page1.htm
- Cooperative Auditing Department. (2015). *Performance and financial report of agricultural cooperatives in 2014*. Retrieved from http://www.cad.go.th/ewtadmin/ewt/statistic/download/report_info/57/kaset_2_57.pdf
- Cooperative Auditing Department. (2016a). *Agricultural cooperatives*. Retrieved from http://cad.go.th/cadweb_eng/ewt_news.php?nid=173

- Cooperative Auditing Department. (2016b). *Cooperative financial information in Thailand*. Retrieved from http://www.cad.go.th/ewtadmin/ewt/statistic/main.php?filename=eng_coop
- Cooperative League of Thailand. (2010). *Cooperative type*. Retrieved from http://www.clt.or.th/main/menu_top_right/clt_information/main_7.php
- Cooperative League of Thailand. (2012). *The historical movement of cooperatives in Thailand*. Retrieved from [http://eng.clt.or.th/index.php?name=page&file=page&op=Historical movement](http://eng.clt.or.th/index.php?name=page&file=page&op=Historical%20movement)
- Cooperative League of Thailand. (2018). *Cooperative credit management guide*. Retrieved from http://www.clt.or.th/main/Pr_news/2561/คู่มือการบริหารสินเชื่อสหกรณ์.pdf
- Cooperative Promotion Department. (2014). *Annual statistics of cooperative, agricultural groups and vocational groups in Thailand 2014*. Retrieved from <http://www.cpd.go.th/cpdn/index.php/coop-movement/annual-statistics>
- Cooperative Promotion Department. (2015). *Thai agricultural cooperatives*. Retrieved from <http://www.cpd.go.th/cpdn/index.php/coop-movement/type-coop>
- Cooperative Promotion Department. (2017). *Agricultural Commodity Bank*. Retrieved from https://www.cpd.go.th/cpdth2560/images/2Agricultural_Bank.pdf
- Cooperative Promotion Department. (2017). *Credit management of agricultural cooperatives*. Retrieved from http://km.cpd.go.th/pdf-bin/pdf_0090774541.pdf
- Cooperative Promotion Department. (2019). *Statistical Information on the cooperative Movement*. Retrieved from <https://www.cpd.go.th/cpdth2560/index.php/information-cpd/general-coop>
- Counting flowers. (2016). *Panmai cooperative*. Retrieved from <https://www.countingflowers.co.uk/about-countingflowers/artisans-of-scarves-and-shawls/7/panmai>
- Cressy, R., & Toivanen, O. (2001). Is there adverse selection in the credit market?. *Venture Capital: An International Journal of Entrepreneurial Finance*, 3(3), 215-238.
- Dardak, R. A. (2015). *Cooperative movement in the supply chain of agricultural products: Way forwards*. Retrieved from http://ap.iftc.agnet.org/ap_db.php?id=512&print=1
- Davis, K., & Nkonya, E. (2008). Developing a methodology for assessing the impact of farmer field schools in East Africa. In *Proceedings of the 24th Annual Meeting of the Association for International Agricultural and Extension Education (AIAEE)* (pp. 93-99).

- DFID. (1999). Sustainable livelihoods guidance sheets. UK DFID Department for International Development: London.
- Di Falco, S., Veronesi, M., & Yesuf, M. (2011). Does adaptation to climate change provide food security? A micro-perspective from Ethiopia. *American Journal of Agricultural Economics*, 93(3), 829-846.
- Diagne, A., Zeller, M., & Sharma, M. P. (2000). Empirical measurements of households' access to credit and credit constraints in developing countries: Methodological issues and evidence (No. 583-2016-39550).
- Doan, T. T. (2011). *Impacts of household credit on the poor in peri-urban areas of Ho Chi Minh City, Vietnam* (Doctoral dissertation, University of Waikato).
- Doan, T., Gibson, J., & Holmes, M. (2014). Impact of household credit on education and healthcare spending by the poor in peri-urban areas, Vietnam. *Journal of Southeast Asian Economies (JSEAE)*, 31(1), 87-103.
- Dubin, J. A., & Rivers, D. (1989). Selection bias in linear regression, logit and probit models. *Sociological Methods & Research*, 18(2-3), 360-390.
- Duong, P. B., & Izumida, Y. (2002). Rural development finance in Vietnam: A microeconometric analysis of household surveys. *World development*, 30(2), 319-335.
- Duvendack, M., Palmer-Jones, R., Copestake, J. G., Hooper, L., Loke, Y., & Rao, N. (2011). What is the evidence of the impact of microfinance on the well-being of poor people?.
- Duy, V. Q., D'Haese, M., Lemba, J., & D'Haese, L. (2012). Determinants of household access to formal credit in the rural areas of the Mekong Delta, Vietnam. *African and Asian studies*, 11(3), 261-287.
- Egziabher, K. G., Mathijs, E., Maertens, M., Deckers, J., & Bauer, H. (2011). Extension participation, household income and income diversification: A system equations approach. In *Proceedings of the CSAE 25th Anniversary Conference 2011: Economic Development in Africa*.
- Elias, A., Nohmi, M., Yasunobu, K., & Ishida, A. (2013). Effect of agricultural extension program on smallholders' farm productivity: Evidence from three peasant associations in the highlands of Ethiopia. *Journal of Agricultural Science*, 5(8), 163-181.

- Feder, G., Just, R. E., & Zilberman, D. (1985). Adoption of agricultural innovations in developing countries: A survey. *Economic development and cultural change*, 33(2), 255-298.
- Feder, G., Lau, L. J., Lin, J. Y., & Luo, X. (1990). The relationship between credit and productivity in Chinese agriculture: A microeconomic model of disequilibrium. *American Journal of Agricultural Economics*, 72(5), 1151-1157.
- Fertő, I., & Szabó, G. G. (2002). The choice of supply channels in Hungarian fruit and vegetable sector, senior research fellow and research fellow institute of economics. In *Hungarian Academy of Sciences, Paper presented at the Annual Meeting of the American Agricultural Economics Association in Long Beach, July* (pp. 5-8).
- Fischer, E., & Qaim, M. (2012). Linking smallholders to markets: Determinants and impacts of farmer collective action in Kenya. *World Development*, 40(6), 1255-1268.
- Fischer, E., & Qaim, M. (2014). Smallholder farmers and collective action: What determines the intensity of participation?. *Journal of Agricultural Economics*, 65(3), 683-702.
- Fongthong, S., & Suriya, K. (2014). Determinants of borrowers of the Village and Urban Community Funds in Thailand. *CMUJ of Social Sciences and Humanities*, 1(1), 21–38.
- Food and Agriculture Organization of the United Nations. (2011). *Agricultural cooperatives are key to reducing hunger and poverty*. Retrieved from <http://www.fao.org/news/story/en/item/93816/icode/>
- Food and Agriculture Organization of the United Nations. (2012a). *Agricultural cooperatives: Paving the way for food security and rural development*. Retrieved from <http://www.fao.org/3/ap088e/ap088e00.pdf>
- Food and Agriculture Organization of the United Nations. (2012b). *Agricultural cooperatives: Key to feeding the world*. Retrieved from <http://www.fao.org/3/i3191e/i3191e00.htm>
- Francesconi, G. N., & Ruben, R. (2007). *Impacts of collective action on smallholders' commercialisation: Evidence from dairy in Ethiopia* (No. 688-2016-47178).
- Francesconi, G. N., & Heerink, N. (2011). Ethiopian agricultural cooperatives in an era of global commodity exchange: Does organisational form matter?. *Journal of African Economies*, 20(1), 153-177.
- Freixas, X., & Rochet, J. C. (2008). *Microeconomics of banking*. MIT press.

- Gertler, P. J., Martinez, S., Premand, P., Rawlings, L. B., & Vermeersch, C. M. (2011). *Impact evaluation in practice*. The World Bank.
- Getnet, K., & Anullo, T. (2012). Agricultural cooperatives and rural livelihoods: Evidence from Ethiopia. *Annals of Public and Cooperative Economics*, 83(2), 181-198.
- Ghana Statistical Service. (2013). *Non-monetary poverty in Ghana*. Retrieved from [https://www.undp.org/content/dam/ghana/docs/Doc/Inclgro/Non-Monetary%20Poverty%20in%20Ghana%20\(24-10-13\).pdf](https://www.undp.org/content/dam/ghana/docs/Doc/Inclgro/Non-Monetary%20Poverty%20in%20Ghana%20(24-10-13).pdf)
- Girma, M., & Abebaw, D. (2015, July). Determinants of formal credit market participation by rural farm households: Micro-level evidence from Ethiopia. In *Paper for presentation at the 13th International Conference on the Ethiopian Economy. Ethiopian Economic Association (EEA) Conference Centre, Addis Ababa, Ethiopia* (pp. 23-25).
- Goetz, S. J. (1992). A selectivity model of household food marketing behavior in sub-Saharan Africa. *American Journal of Agricultural Economics*, 74(2), 444-452.
- Grameen Bank. (2017). *10 indicators to assess poverty level*. Retrieved from <http://www.grameen.com/10-indicators/>
- Grashuis, J., & Su, Y. (2019). A review of the empirical literature on farmer cooperatives: Performance, ownership and governance, finance, and member attitude. *Annals of Public and Cooperative Economics*, 90(1), 77-102.
- Grosh, M., & Glewwe, P. (2000). Designing household survey questionnaires for developing countries. *World Bank Publications*.
- Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2013). *Multivariate data analysis: Pearson new international edition*. Pearson Higher Ed.
- Haughton, J., & Khandker, S. R. (2009). *Handbook on poverty and inequality*. World Bank Publications.
- Hazell, P., Poulton, C., Wiggins, S., & Dorward, A. (2010). The future of small farms: Trajectories and policy priorities. *World Development*, 38(10), 1349-1361.
- Heckman, J. J., Ichimura, H., & Todd, P. E. (1997). Matching as an econometric evaluation estimator: Evidence from evaluating a job training programme. *The review of economic studies*, 64(4), 605-654.

- Heinemann, E., Prato, B., & Shepherd, A. (2011). *Rural Poverty Report 2011: New realities, new challenges: New opportunities for tomorrow's generation*. International Fund for Agricultural Development (IFAD).
- Heinrich, C., Maffioli, A., & Vazquez, G. (2010). *A primer for applying propensity-score matching*. Inter-American Development Bank.
- Herath, H. M. W. A., Gunaratne, L. H. P., & Sanderatne, N. (2013). Impact of credit-plus approach of microfinance on income generation of households. *Sri Lanka Journal of Economic Research*, 1(1), 57–75.
- Hill, R. C., Griffiths, W. E., & Lim, G. C. (2011). *Principles of econometrics*. Wiley.
- Hoken, H. (2016). *Participation in farmer's cooperatives and its effects on agricultural incomes: Evidence from vegetable-producing areas in China* (No. 578). Institute of Developing Economies, Japan External Trade Organization (JETRO).
- Hoken, H., & Su, Q. (2015). *Measuring the effect of agricultural cooperatives on household income using PSM-DID: A case study of a rice-producing cooperative in China* (No. 539). Institute of Developing Economies, Japan External Trade Organization (JETRO).
- Holloway, G., Nicholson, C., Delgado, C., Staal, S., & Ehui, S. (2000). Agroindustrialization through institutional innovation transaction costs, cooperatives and milk-market development in the East-African highlands. *Agricultural economics*, 23(3), 279-288.
- Holvoet, N. (2004). Impact of microfinance programs on children's education: Do the gender of the borrower and the delivery model matter?. *Journal of Microfinance/ESR Review*, 6(2), 3.
- Hulme, D. (2000). Impact assessment methodologies for microfinance: Theory, experience and better practice. *World development*, 28(1), 79-98.
- Hulme, D., & Mosley, P. (1996). *Finance against poverty* (Vol. 2). Psychology Press.
- Intawang, A., & Wingwon, B. (2014). Effect of supply chain management business networking toward operational performance of Agricultural Marketing Cooperatives (AMC) in upper northern Thailand. *Journal of Management Science Chiangrai Rajabhat University*, 9(2), 42-59.
- Iqbal, F. (1983). The demands for funds by agricultural households: Evidence from rural India. *The Journal of Development Studies*, 20(1), 68-86.

- Iqbal, F. (1986). The demand and supply of funds among agricultural households in India. *Agricultural household models: Extensions, applications and policy*. John Hopkins University Press, Baltimore, 183-205.
- Islam, T. (2008). Microcredit and poverty alleviation: The Grameen bank in focus. *Journal of Social and Economic Development*, 10(1), 33–49.
- Ito, J., Bao, Z., & Su, Q. (2012). Distributional effects of agricultural cooperatives in China: Exclusion of smallholders and potential gains on participation. *Food policy*, 37(6), 700-709.
- Jena, P. R., Chichaibelu, B. B., Stellmacher, T., & Grote, U. (2012). The impact of coffee certification on small-scale producers' livelihoods: A case study from the Jimma Zone, Ethiopia. *Agricultural economics*, 43(4), 429-440.
- Johnson, W., Kitamura, Y., & Neal, D. (2000). Evaluating a simple method for estimating black-white gaps in median wages. *The American Economic Review*, 90(2), 339–343.
- Kaboski, J. P., & Townsend, R. M. (2012). The impact of credit on village economies. *American Economic Journal: Applied Economics*, 4(2), 98-133.
- Kainara, C. (2015). Development of agricultural market through cooperative system and enhancing of sustainable competitiveness for agricultural cooperatives in Central region of Thailand. *Economic and Social Journal*, 52(4).
- Kannan, E. (2011). Relationship between agricultural credit policy, credit disbursements and crop productivity: A study in Karnataka. *Indian Journal of Agricultural Economics*, 66(902-2016-67329).
- Key, N., Sadoulet, E., & Janvry, A. D. (2000). Transactions costs and agricultural household supply response. *American journal of agricultural economics*, 82(2), 245-259.
- Khoi, P. D. (2012). *An empirical analysis of accessibility and impact of microcredit: The rural credit market in the Mekong River Delta, Vietnam* (Doctoral dissertation, Lincoln University).
- Khoi, P. D., Gan, C., Nartea, G. V., & Cohen, D. A. (2013). Formal and informal rural credit in the Mekong River Delta of Vietnam: Interaction and accessibility. *Journal of Asian Economics*, 26, 1-13.

- Kimhi, A. (1999). Estimation of an endogenous switching regression model with discrete dependent variables: Monte-Carlo analysis and empirical application of three estimators. *Empirical Economics*, 24(2), 225-241.
- Kondo, T., Orbeta Jr, A., Dingcong, C., & Infantado, C. (2008). Impact of microfinance on rural households in the Philippines. *IDS bulletin*, 39(1), 51-70.
- Land Development Department. (2019). *Water resource supply for non-irrigated areas*. Retrieved from https://www.ddd.go.th/WEB_Water/Index.html
- Lee, In-Woo. (2006). Agricultural cooperatives in Asia: Innovations and opportunities for the 21st century. In *2006 FFTCNACF International seminar on agricultural cooperatives in Asia: Innovations and Opportunities in the 21st century* (pp. 11-15). Seoul, Korea.
- Lewis, S., Tambunlertchai, K., Suesuwan, E., Adair, M., & Hickson, R. (2013). *Technical assistance consultant's report: Microfinance supply-side assessment report* (No. TA7998). Retrieved from <http://www.adb.org/projects/45128-001/documents> *Finscope
- Li, X., Gan, C., & Hu, B. (2011a). Accessibility to microcredit by Chinese rural households. *Journal of Asian Economics*, 22(3), 235-246.
- Li, X., Gan, C., & Hu, B. (2011b). The welfare impact of microcredit on rural households in China. *The Journal of Socio-Economics*, 40(4), 404-411.
- Lokshin, M., & Sajaia, Z. (2004). Maximum likelihood estimation of endogenous switching regression models. *The Stata Journal*, 4(3), 282-289.
- Lokshin, M., & Sajaia, Z. (2011). Impact of interventions on discrete outcomes: Maximum likelihood estimation of the binary choice models with binary endogenous regressors. *The Stata Journal*, 11(3), 368-385.
- Limsombunchai, V. (2006). *Rural finance in Thailand* (Doctoral dissertation, Lincoln University).
- Ma, W., & Abdulai, A. (2016). Does cooperative membership improve household welfare? Evidence from apple farmers in China. *Food Policy*, 58, 94-102.
- Ma, W. (2016). *The impact of agricultural cooperatives on the adoption of technologies and farm performance of apple farmers in China* (Doctoral dissertation, Christian-Albrechts Universität Kiel).

- Majee, W., & Hoyt, A. (2010). Are worker-owned cooperatives the brewing pots for social capital?. *Community Development*, 41(4), 417-430.
- McFadden, D. (1977). *Quantitative methods for analyzing travel behavior of individuals: Some recent developments*. Berkeley: Institute of Transportation Studies, University of California.
- Menkhoff, L., & Rungruxsirivorn, O. (2011). Do village funds improve access to finance? Evidence from Thailand. *World development*, 39(1), 110-122.
- Mensah, E. R., Karantininis, K., Adégbidi, A., & Okello, J. J. (2012). *Determinants of commitment to agricultural cooperatives: Cashew nuts farmers in Benin* (No. 1007-2016-79578).
- Microfinance Services Ltd. (2013). *Technical assistance consultant's report: Thailand financial inclusion synthesis assessment report*. Retrieved from <http://www.adb.org/projects/45128-001/documents>
- Ministry of Education Thailand. (2010). *Education development policy: Free education for 15 years*. Retrieved from http://www.moe.go.th/index.php/ข่าวประกาศ/เรียนฟรี-15-ปี-นโยบายสำคัญพัฒนาคุณภาพการศึกษา/news_research/17362
- Mishkin, F. S. (2007). *The economics of money, banking, and financial markets*. Pearson education.
- Milde, H., & Riley, J. G. (1988). Signalling in credit markets. *The Quarterly Journal of Economics*, 103(1), 101-129.
- Ministry of Agriculture Forestry and Fisheries. (2005). *Cooperative movement in Thailand: Report of study tour*. Retrieved from http://www.inter-reseaux.org/IMG/pdf/Thailand_cooperative__movement_2005_english-2.pdf
- Miranda, A., & Rabe-Hesketh, S. (2006). Maximum likelihood estimation of endogenous switching and sample selection models for binary, ordinal, and count variables. *The stata journal*, 6(3), 285-308.
- Mojo, D., Fischer, C., & Degefa, T. (2015a). Social and environmental impacts of agricultural cooperatives: Evidence from Ethiopia. *International Journal of Sustainable Development & World Ecology*, 22(5), 388-400.
- Mojo, D., Fischer, C., & Degefa, T. (2015b). *Who benefits from collective action? Determinants and economic impacts of coffee farmer cooperatives in Ethiopia* (No. 1008-2016-80101).

- Mojo, D., Fischer, C., & Degefa, T. (2017). The determinants and economic impacts of membership in coffee farmer cooperatives: Recent evidence from rural Ethiopia. *Journal of Rural Studies*, 50, 84-94.
- Muthyalu, M. (2013). The factors that influence the participation of co-operative members in the agricultural input and output marketing: A case study of Adwa district, Ethiopia. *Journal of Business Management and Social Sciences Research*, 2(4), 121–130.
- Nakhonratchasima Provincial Cooperative Office. (2016). *Data of cooperative and farmer group in 2016*. Retrieved from <http://web.cpd.go.th/nakhonratchasima/index.php/infocpd/ictcoop#>
สารสนเทศสหกรณ์
- Nakhonratchasima Provincial Governor's Office. (2016). *Nakhonratchasima province data*. Retrieved from http://www.nakhonratchasima.go.th/data_nakhonratchasima.pdf
- National Statistical Office. (2013). *Agricultural census whole kingdom*. Retrieved from <http://www.nso.go.th/sites/2014en/Pages/Census/Agricultural-Census.aspx>
- Netayarak, P. (1998). *Rural credit market in Thailand, 1996*. Thailand Development Research Institute.
- Nghiem, H. S., Coelli, T. J., & Rao, P. (2007). *The welfare effects of microfinance in Vietnam: Empirical results from a quasi-experiment survey* (No. 418-2016-26538).
- Nguyen, C. H. (2007). Determinants of credit participation and its impact on household consumption: Evidence from rural Vietnam (No. 2007/03).
- Niëns, L. M., Van de Poel, E., Cameron, A., Ewen, M., Laing, R., & Brouwer, W. B. F. (2012). Practical measurement of affordability: An application to medicines. *Bulletin of the World Health Organization*, 90, 219-227.
- O'donnell, O., Van Doorslaer, E., Wagstaff, A., & Lindelow, M. (2007). *Analyzing health equity using household survey data: A guide to techniques and their implementation*. The World Bank.
- Office of Agricultural Economics. (2014). *Debt situation of agricultural households in present*. Retrieved from http://www.oae.go.th/ewt_news.php?nid=17495&filename=index
- Office of Agricultural Economics. (2016). *Agricultural economics report, 2016*. Retrieved from http://www.oae.go.th/download/download_journal/2559/commodity58.pdf

- Office of the National Economic and Social Development Council. (2015). *Thailand poverty and inequality analysis 2013* (Report). Bangkok, Thailand.
- Official Statistics Registration Systems. (2016). *Population and household statistics at current database*. Retrieved September 26, 2016, from <http://stat.dopa.go.th/stat/statnew/statMenu/newStat/home.php>
- Ololade, R. A., & Olagunju, F. I. (2013). Determinants of access to credit among rural farmers in Oyo State, Nigeria. *Global Journal of Science Frontier Research Agriculture and Veterinary Sciences*, 13(2), 16-22.
- Omoro, N. O., & Omwange, A. M. (2013). The utilization of microfinance loans and household welfare in the emerging markets. *European International Journal of Science and Technology*, 2(3), 59-78.
- Ortmann, G. F., & King, R. P. (2007). Agricultural cooperatives II: Can they facilitate access of small-scale farmers in South Africa to input and product markets?. *Agrekon*, 46(2), 219-244.
- Oseni, G., Huebler, F., McGee, K., Amankwah, A., Legault, E., & Rakotonarivo, A. (2018). *Measuring household expenditure on education: A guidebook for designing household survey questionnaires*. Retrieved from <http://surveys.worldbank.org/publications/measuring-household-expenditure-education>
- Ouma, E., Jagwe, J., Obare, G. A., & Abele, S. (2010). Determinants of smallholder farmers' participation in banana markets in Central Africa: The role of transaction costs. *Agricultural Economics*, 41(2), 111-122.
- Patrawart, J., & Sriurai, S. (2010). *Value chain management in agricultural co-operatives, Thailand: Innovation for competitiveness and fair-trade approaches*. In ICA European Research Conference, 1-6 September 2010 (pp. 1-14). Lyon, France.
- Patrawart, J., Triketthamphan, N., Lekudornkorn, K., Sangpheth, N., & Ausakulwattana, N. (2001). *Cooperative literature review in 1990-2000 (Report for the Thailand Research Fund)*. Bangkok, Thailand.
- Pence, K. M. (2006). The role of wealth transformations: An application to estimating the effect of tax incentives on saving. *The BE Journal of Economic Analysis & Policy*, 5(1).
- Pitt, M. M., & Khandker, S. R. (1998). The impact of group-based credit programs on poor households in Bangladesh: Does the gender of participants matter?. *Journal of political economy*, 106(5), 958-996.

- Pleehachinda, S. (2003). AC Project evaluation: Productivity development. *Kasetsart University Journal of Economics*, 10(1).
- Poapongsakorn, N. (2014). *Management of farm households' debt for sustainable livelihood*. Retrieved from http://www.oae.go.th/ewt_dl.php?nid=19791
- Poapongsakorn, N., Hengtakul, J., Anucitworong, C., Intaravitak, C., Arayapong, A., Chansiri, A., Greemee, M. (2015). *The study of farmer debt situation and the way to develop performance of funds under ministry of agriculture and cooperatives (Report for Thailand Development Research institute)*. Bangkok, Thailand.
- Prakash, D. (2000). Development of agricultural cooperatives-relevance of Japanese experiences to developing countries. *14th ICA-Japan International Training Course on "Strengthening Management of Agricultural Cooperatives in Asia" held at IDACA-Japan on April, 18, 2000*.
- Pratuckchai, W., & Patichol, P. (2016). 100 Years of Thai cooperatives: History and future development trends. *Bangkok: The Cooperative League of Thailand*.
- Preedasak, P. (1998). *Financial market in rural Thailand: Role of agricultural cooperatives and saving groups on financial market in rural (Report for Thailand Development Research Institution)*. Bangkok, Thailand.
- Preedasak, P., & NaRanong, V. (2001). *Roles of agricultural cooperatives and village credit unions in rural financial markets in Thailand*. Retrieved from <http://www.fao.org/3/ac158e/ac158e00.htm#Contents>
- Pronyk, P. M., Hargreaves, J. R., & Morduch, J. (2007). Microfinance programs and better health: Prospects for sub-Saharan Africa. *JAMA*, 298(16), 1925-1927.
- Quach, M. H. (2005). *Access to finance and poverty reduction: An application to rural Vietnam* (Doctoral dissertation, University of Birmingham).
- Ratanamalai, A. (2001). Thailand cooperatives role in decentralized rural development for poverty alleviation and food security at the community level. *Session at Decentralized rural development and the role of self help organizations: A regional workshop*, offered by the Food and Agriculture Organization Regional Office for Asia and the Pacific Bangkok, Chiang Mai, Thailand.
- Ratanamaneichat, C., Rakkarn, S., Suwandee, S., & Nakrungrueng, W. (2016). A development model for sustainable Thai Agricultural Co-operatives. *Kasem Bundit Journal*, 17(2), 16-25.

- Ratanavararak, L., Chatarat, S., Rittinon, C., Sangimnet, B., Unahalekhaka, A., Chinchotithiranun, R., & Pantakua, K. (2019). *Digital technology and Thai farmers' well-being improvement*. Retrieved from https://www.pier.or.th/wp-content/uploads/2019/10/aBRIDGEd_2019_019.pdf
- Reed, L. R. (2011). State of the microcredit summit campaign report 2011. Microcredit summit campaign. *Washington, DC*.
- Registrar and Law Office. (2016). *Agricultural cooperatives*. Retrieved from www.cpd.go.th
- Ritthaisong, Y., Akasart, E., Apisitpinyo, B., Tungprasert, S., & Jumpasri, S. (2018). The improvement of supply chain performance of Thung Sumrit Jasmine Rice to enhance firm competitiveness: The case study of Pimai Agricultural Cooperative, Pimai district, Nakhon Ratchasima. *Journal of Business Administration*, 7(1), 123-145.
- Rivers, D., & Vuong, Q. H. (1988). Limited information estimators and exogeneity tests for simultaneous probit models. *Journal of econometrics*, 39(3), 347-366.
- Ross, K. N. (2005). Sample design for educational survey research. *Evaluation in Education. International Progress*, 2(2), 105-195.
- Ruete, M. (2014). Inclusive investment in agriculture: Cooperatives and the role of foreign investment. *Policy Brief*, 2.
- Sakonhawatt, Arnunchanok, Iswilanon, S., & Palarnuluk, P. (2012). *Dynamic of poverty: Farmer households in rural area of Northeast and Central of Thailand*. Retrieved from <https://dric.nrct.go.th/index.php?/Search/SearchDetail/249894>
- Sebopetji, T. O., & Belete, A. (2009). An application of probit analysis to factors affecting small-scale farmers decision to take credit: A case study of the Greater Letaba Local Municipality in South Africa. *African journal of agricultural research*, 4(8), 718-723.
- Sekaran, U., & Bougie, R. (2016). *Research methods for business: A skill building approach*. John Wiley & Sons.
- Setboonsarng, S., & Parpiev, Z. (2008). *Microfinance and the millennium development goals in Pakistan: Impact assessment using propensity score matching* (No. 104). ADB institute discussion papers.
- Shiferaw, B., Kassie, M., Jaleta, M., & Yirga, C. (2014). Adoption of improved wheat varieties and impacts on household food security in Ethiopia. *Food Policy*, 44, 272-284.

- Shimamura, Y., & Lastarria-Cornhiel, S. (2010). Credit program participation and child schooling in rural Malawi. *World Development*, 38(4), 567-580.
- Siamrath Publishing Corporation. (2020). *Drought solution: 700 million bahts for drilling a well on farm*. Retrieved from <https://siamrath.co.th/n/129487>
- Siamturakij Publishing Corporation. (2013). *Rice market enhancement, Nakhonratchasima*. Retrieved from <https://www.siamturakij.com/news/3809-โครงการขยายตลาดข้าวหอมมะลิ>
- Siamwalla, A., Pinthong, C., Poapongsakorn, N., Satsanguan, P., Nettayarak, P., Mingmaneeenakin, W., & Tubpun, Y. (1990). The Thai rural credit system: Public subsidies, private information, and segmented markets. *The World Bank economic review*, 4(3), 271-295.
- Singh, I., Squire, L., & Strauss, J. (1986). Agricultural household models: Extensions, applications, and policy.
- Sinha, S., & Rasmussen, S. (2007). *Microfinance in South Asia: Toward financial inclusion for the poor*. World Bank.
- Smith, J. A., & Todd, P. E. (2005). Does matching overcome LaLonde's critique of nonexperimental estimators?. *Journal of econometrics*, 125(1-2), 305-353.
- Smith, S. M. (2011). Cooperatives 101: An introduction to agricultural cooperatives and the federal regulations and legal concerns that impact them. *Washington: US Department of Agriculture*, 4.
- Somavia, J. (2003). Working out of poverty. Report of the Director-General. International Labour Conference 91st Session 2003.
- Strategic Studies Center. (2017). *Roles of Thai army in supporting the government policies: A case study of sustainable solution for rice farmers*. Retrieved from http://www.sscthailand.org/uploads_ssc/research_201808241535077967321246.pdf
- Steijvers, T., & Voordeckers, W. (2009). Collateral and credit rationing: A review of recent empirical studies as a guide for future research. *Journal of Economic Surveys*, 23(5), 924-946.
- Stiglitz, J. E., & Weiss, A. (1981). Credit rationing in markets with imperfect information. *The American economic review*, 71(3), 393-410.
- Suradisastra, K. (2006). Agricultural cooperative in Indonesia. *FFTC-NCCF South Kores*, 1-14.

- Suasuwat, A. (2014). *An assistance reform for rice farmer and rice sustainability development in Thailand*. Bangkok: Sukhothai Thammathirat Open University.
- Swain, R. B. (2007). The demand and supply of credit for households. *Applied Economics*, 39(21), 2681-2692.
- Takahashi, K., Higashikata, T., & Tsukada, K. (2010). The short-term poverty impact of small-scale, collateral-free microcredit In Indonesia: A matching estimator approach. *The Developing Economies*, 48(1), 128-155.
- Tamirat, M. (2015). *The Role of agricultural cooperatives in building sustainable livelihood for rural women: A case study of women members of Garagodo & Hembecho Cooperatives, Bolloso Sore Woreda, Wolaita Zone, SNNPR* (Doctoral dissertation, Addis Ababa University).
- Tanrattaphong, B. (2015). *Successful cases of agricultural cooperatives marketing activities for improving marketing efficiency in Thailand*. Retrieved from http://ap.fttc.agnet.org/ap_db.php?id=519
- Tereda, A. (2011). *The role of agricultural marketing cooperatives in reducing rural poverty: The case of Yirgachefe and Sidama-Elto cooperative union in SNNP regional state* (Doctoral dissertation, Addis Ababa University).
- Tetteh Anang, B., Sipiläinen, T. A. I., Bäckman, S. T., & Kola, J. T. S. (2015). Factors influencing smallholder farmers' access to agricultural microcredit in Northern Ghana. *African Journal of Agricultural Research*, 10(24), 2460-2469.
- Thailand Development Research Institution. (2004). *Micro-banking development (Report)*. Bangkok, Thailand.
- Thailand Development Research Institution. (2015). *Debt of Thai household equals to USA*. Retrieved from <http://tdri.or.th/tdri-insight/20150330/>
- Thai Farmers' Library. (2019). *Project of jasmin rice quality support assists farmers to reduce a seed cost*. Retrieved from <http://thaifarmer.lib.ku.ac.th/news/5d9be8d03df0a668191de27e>
- Thayang Agricultural Co-operative Ltd. (2016). *Businesses of Thayang Agricultural Co-operative Ltd*. Retrieved from <http://www.coopthai.com/cpd/thayang/turakit.html>
- Thongpukdee, W. (2011). *Factors affecting demand for agricultural credit of members of Phra Nakhon Si Ayutthaya Agricultural Cooperative Ltd* (Master thesis, Kasetsart University).

- Thuvachote, S. (2007). *Agricultural cooperatives in Thailand : Innovations and opportunities in the 21st century*. Retrieved September 9, 2016, from <http://www.fftcc.agnet.org/library.php?func=view&id=20110726094659>
- Thuvachote, S. (2011). Cooperatives and poverty reduction in Thailand. In *the 2nd International Conference on Economics, Business and Management*. Singapore.
- Tiwari, K. R., Sitaula, B. K., Nyborg, I. L., & Paudel, G. S. (2008). Determinants of farmers' adoption of improved soil conservation technology in a middle mountain watershed of Central Nepal. *Environmental management*, 42(2), 210-222.
- Townsend, R. M., Killian, E., & Killian, J. (2016). *Townsend Thai household annual resurvey urban and rural data summaries*. Retrieved from [http://townsend-thai.mit.edu/data/Urban VS Rural Data Summaries_Aug16.pdf](http://townsend-thai.mit.edu/data/Urban%20VS%20Rural%20Data%20Summaries_Aug16.pdf)
- Tsukada, K., Higashikata, T., & Takahashi, K. (2010). Microfinance penetration and its influence on credit choice in Indonesia: Evidence from a household panel survey. *The Developing Economies*, 48(1), 102-127.
- United Nations Development Programme. (1997). *Human development report 1997*. United Nations Development Programme.
- Verhofstadt, E., & Maertens, M. (2014). Smallholder cooperatives and agricultural performance in Rwanda: Do organizational differences matter?. *Agricultural Economics*, 45(S1), 39-52.
- Verhofstadt, E., & Maertens, M. (2015). Can agricultural cooperatives reduce poverty? Heterogeneous impact of cooperative membership on farmers' welfare in Rwanda. *Applied Economic Perspectives and Policy*, 37(1), 86-106.
- Vijitsrikamol, K., Bunyasiri, I., Sirijinda, A., & Kitchaicharoen, J. (2013). *Poverty assessment, opportunity to access financial organizations, and impacts of financial organizations on livelihood of highland households in Mae Sa Watershed Area, Chiang Mai province (Report for National Research Council of Thailand)*. Thailand.
- Wanyama, F. O., Develtere, P., & Pollet, I. (2008). Encountering the evidence: Cooperatives and poverty reduction in Africa. *Journal of Co-Operative Studies*, 41(3), 16–27.
- Williams, R. C. (2007). *What makes a cooperative work? In the cooperative movement: Globalization from below*. Retrieved from http://library.uniteddiversity.coop/Cooperatives/The_Cooperative_Movement.pdf

- Williamson, L. (1987). Farmer and consumer cooperatives structure and classification. *AEC-University of Kentucky, Cooperative Extension Service (USA)*.
- Winter-Nelson, A., & Temu, A. (2005). Impacts of prices and transactions costs on input usage in a liberalizing economy: Evidence from Tanzanian coffee growers. *Agricultural Economics*, 33(3), 243-253.
- Wollni, M., & Zeller, M. (2007). Do farmers benefit from participating in specialty markets and cooperatives? The case of coffee marketing in Costa Rica. *Agricultural Economics*, 37(2-3), 243-248.
- Wooldridge, J. M. (2010). *Econometric analysis of cross section and panel data*. MIT press.
- World Bank. (2000). *World development report 2000-2001: Attacking poverty*. World Bank Group.
- World Bank. (2007). *World development report 2008: Agriculture for development*. World Bank.
- World Bank. (2015). *How is the global poverty line derived? How is it different from national poverty lines?* Retrieved from <https://datahelpdesk.worldbank.org/knowledgebase/articles/193310-how-is-the-global-poverty-line-derived-how-is-it>
- World Bank. (2016a). Global monitoring report 2015/2016: Development goals in an era of demographic change. *Washington, DC: World Bank*.
- World Bank. (2016b). Rural population. *Washington, DC: World Bank*.
- World Bank. (2018). *The World Bank in Thailand*. Retrieved from <https://www.worldbank.org/en/country/thailand/overview>
- World Bank. (2019). Poverty and equity. *Washington, DC: World Bank*.
- Wossen, T., Abdoulaye, T., Alene, A., Haile, M. G., Feleke, S., Olanrewaju, A., & Manyong, V. (2017). Impacts of extension access and cooperative membership on technology adoption and household welfare. *Journal of rural studies*, 54, 223-233.
- Zeller, M. (1994). Determinants of credit rationing: A study of informal lenders and formal credit groups in Madagascar. *World development*, 22(12), 1895-1907.
- Zeuli, K. A., Cropp, R., & Schaars, M. A. (2004). Cooperatives: Principles and practices in the 21st century.

- Zhang, B., Fu, Z., Wang, J., Tang, X., Zhao, Y., & Zhang, L. (2017). Effect of householder characteristics, production, sales and safety awareness on farmers' choice of vegetable marketing channels in Beijing, China. *British Food Journal*, 119(6), 1216-1231.
- Zheng, S., Wang, Z., & Song, S. (2011). Farmers' behaviors and performance in cooperatives in Jilin Province of China: A case study. *The social science journal*, 48(3), 449-457.
- Zhong, Z., Zhang, C., Jia, F., & Bijman, J. (2018). Vertical coordination and cooperative member benefits: Case studies of four dairy farmers' cooperatives in China. *Journal of Cleaner Production*, 172(2018), 2266-2277.

Appendices

Appendix A: Determinants of AC Participation

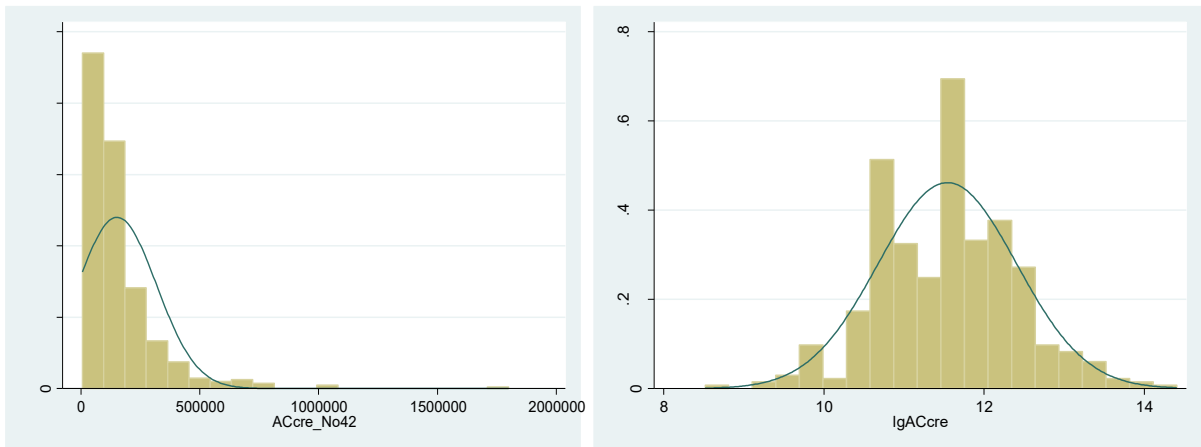
A.1 Reliability Test of Risk Factors and AC Benefit Expectation

Factors	Number of variables	Cronbach's Alpha	Means	Variance
Pro_Risk	5	0.615	2.966	1.319
Mkt_Risk	5	0.665	2.283	0.220
Fin_Risk	4	0.795	2.557	0.446
Cre_Be	2	0.757	3.985	0.045
Mkt_Be	3	0.789	3.716	0.074
Ext_Be	2	0.764	3.058	0.032

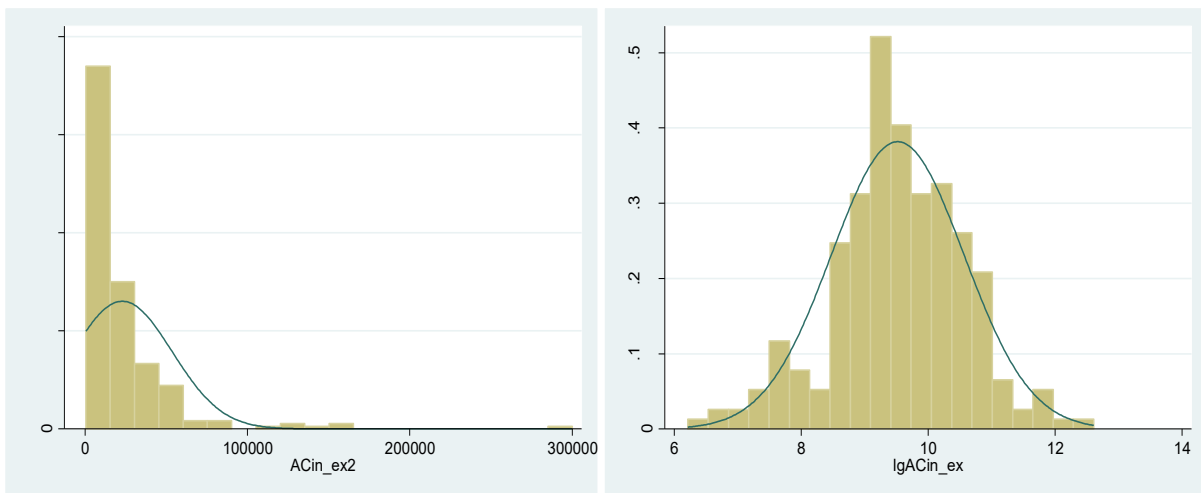
Note: Computed by the authors using 2017 survey data.

A.2 Distribution of Participation Level and log Participation Level

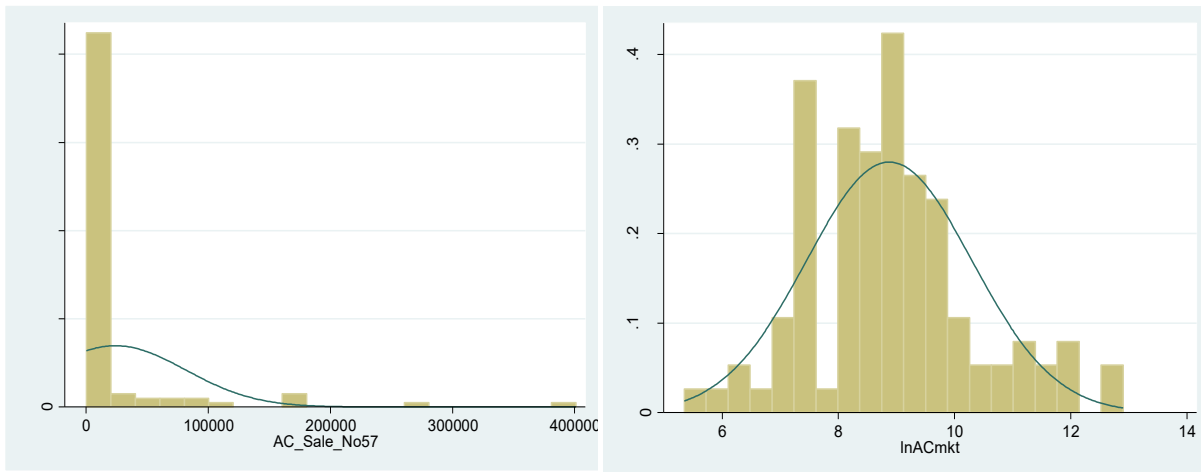
A.2.1 Distribution of AC Loan and Log of AC Loan



A.2.2 Distribution of AC Input Expenditure and Log of AC Input Expenditure



A.2.3 Distribution of AC sale amount and Log of AC sale amount



A.3 Results of Endogeneity Problem for AC Participation and AC Credit Participation

A.3.1 Results of a Valid Instrumental Variable for AC Participation

Independent Variables	Dependent Variables				Dependent Variables			
	Cre_Use (EEV)		AC_Mem		Ext_Acc (EEV)		AC_Mem	
	Coefficient	R.S.E.	Coefficient	R.S.E.	Coefficient	R.S.E.	Coefficient	R.S.E.
Age_Yr	-0.015***	(0.005)	0.007	(0.008)	0.008	(0.005)	0.007	(0.008)
Edu_Yr	-0.070***	(0.017)	-0.019	(0.025)	0.034**	(0.016)	-0.019	(0.025)
Sex			-0.320**	(0.147)	-0.218**	(0.100)	-0.320**	(0.147)
Mari					0.350***	(0.129)		
Paddy			-0.711***	(0.242)	0.212	(0.146)	-0.711***	(0.242)
Orchard			-0.276	(0.289)	-0.405**	(0.203)	-0.276	(0.289)
Cash_Crop			0.631***	(0.219)	0.306**	(0.143)	0.631***	(0.219)
Inc_Pr	-1.597***	(0.497)	0.035	(0.717)			0.035	(0.717)
Inc_UPr	-0.192	(0.215)	0.171	(0.288)			0.171	(0.288)
Inc_NPr	-0.023	(0.188)	0.308	(0.243)			0.308	(0.243)
Farm_Mem	0.016	(0.062)	-0.046	(0.081)			-0.046	(0.081)
Farm_Si	0.009***	(0.003)	0.016**	(0.007)	-0.003	(0.002)	0.016**	(0.007)
Farm_Sq			7.04e-05**	(3.10e-05)			-7.04e-05**	(3.10e-05)
Land	-0.249	(0.178)	-0.273	(0.269)	0.199	(0.156)	-0.273	(0.269)
Irr_Acc	-0.316***	(0.104)						
Ext_Acc	0.412***	(0.111)	0.633***	(0.166)			0.633***	(0.166)
Oth_Mem (IV)	0.980***	(0.122)	-0.121	(0.207)	0.283**	(0.124)	-0.121	(0.207)
Cre_Use			0.982***	(0.166)	0.421***	(0.117)	0.982***	(0.166)
Pro_Risk	0.005	(0.064)	-0.570***	(0.109)	0.074	(0.065)	-0.570***	(0.109)
Mkt_Risk	0.009	(0.075)	-0.023	(0.106)	-0.197***	(0.067)	-0.023	(0.106)
Fin_Risk	0.106*	(0.060)	0.278***	(0.093)	0.086*	(0.052)	0.278***	(0.093)
Sat			0.241**	(0.116)			0.241**	(0.116)
Eff			-0.084	(0.092)			-0.084	(0.092)
Cre_be			0.205***	(0.057)			0.205***	(0.057)
Ext_be			-0.038	(0.042)			-0.038	(0.042)
Inp_Acc			-0.077	(0.115)			-0.077	(0.115)
Out_Acc			-0.073	(0.109)			-0.073	(0.109)
Inf_Acc			0.228***	(0.077)			0.228***	(0.077)
Dis_Town	0.0123**	(0.005)			-0.010**	(0.004)		
Dist_N			0.833***	(0.203)	0.148	(0.129)	0.833***	(0.203)
Dist_S			0.138	(0.220)	0.227*	(0.133)	0.138	(0.220)
AC_Rela			1.331***	(0.213)			1.331***	(0.213)
AC_Vill			0.980***	(0.235)			0.980***	(0.235)
Constant	0.660	(0.500)	-3.071***	(0.867)	-1.224**	(0.484)	-3.071***	(0.867)
Observations	850		616		850		616	
Wald chi2 (30)	148.54***		207.73***		69.31***		207.73***	
Pseudo R2	0.184		0.418		0.0726		0.418	

Note: 1. *, **, and *** Indicate significance level at 10%, 5%, and 1%, respectively.

2. Computed by the authors using 2017 survey data.

A.3.2 Result of Endogeneity Problem in AC Participation

Independent Variables	Dependent Variables				Dependent Variables			
	Cre_Use (EEV)		AC_Mem		Ext_Acc (EEV)		AC_Mem	
	Coefficient	R.S.E	Coefficient	R.S.E	Coefficient	R.S.E	Coefficient	R.S.E
Age_Yr	-0.005***	(0.002)	0.007	(0.009)	0.003*	(0.002)	0.011	(0.009)
Edu_Yr	-0.020***	(0.005)	-0.021	(0.029)	0.011**	(0.005)	-0.003	(0.028)
Sex			-0.318**	(0.147)	-0.072**	(0.034)	-0.413**	(0.161)
Mari					0.120***	(0.045)		
Paddy			-0.715***	(0.240)	0.070	(0.046)	-0.583**	(0.270)
Orchard			-0.269	(0.290)	-0.147**	(0.072)	-0.468	(0.314)
Cash_Crop			0.643***	(0.219)	0.098**	(0.044)	0.758***	(0.242)
Inc_Pr	-0.496***	(0.121)	0.006	(0.747)			0.062	(0.716)
Inc_UPr	-0.047	(0.059)	0.179	(0.286)			0.178	(0.288)
Inc_NPr	0.004	(0.049)	0.310	(0.242)			0.313	(0.240)
Farm_Mem	0.008	(0.017)	-0.043	(0.081)			-0.036	(0.081)
FarmSi_Aft	0.002***	(0.0005)	0.016**	(0.007)	-0.0009	(0.0007)	0.014**	(0.007)
Farm_Sq	-0.065	(0.042)	6.95e-05**	(3.09e-05)			-7.02e-05**	(3.11e-05)
Land	-0.086***	(0.028)	-0.274	(0.270)	0.066	(0.055)	-0.168	(0.268)
Irr_Acc	0.113***	(0.033)						
Cre_Use			0.918*	(0.550)	0.141***	(0.041)	1.160***	(0.226)
Ext_Acc			0.625***	(0.184)			-0.646	(1.023)
Oth_Mem (IV)	0.332***	(0.042)			0.103**	(0.045)		
Pro_Risk	0.0007	(0.018)	-0.575***	(0.109)	0.022	(0.021)	-0.536***	(0.113)
Mkt_Risk	0.0008	(0.020)	-0.016	(0.106)	-0.064***	(0.021)	-0.100	(0.132)
Fin_Risk	0.027*	(0.016)	0.273***	(0.095)	0.027	(0.017)	0.317***	(0.098)
Sat			0.233**	(0.117)			0.235**	(0.116)
Eff			-0.082	(0.092)			-0.076	(0.092)
Cre_be			0.204***	(0.057)			0.210***	(0.057)
Ext_be			-0.038	(0.042)			-0.036	(0.042)
Inp_Acc			-0.076	(0.115)			-0.089	(0.114)
Out_Acc			-0.077	(0.109)			-0.069	(0.109)
Inf_Acc			0.229***	(0.077)			0.229***	(0.078)
Dis_Town	0.003***	(0.001)			-0.003**	(0.001)		
Dist_N			0.841***	(0.203)	0.050	(0.041)	0.896***	(0.210)
Dist_S			0.134	(0.219)	0.078*	(0.043)	0.227	(0.238)
AC_Rela			1.328***	(0.214)			1.325***	(0.214)
AC_Vill			0.986***	(0.235)			0.985***	(0.236)
Residual			0.041	(0.557)			1.303	(1.041)
Constant	0.691***	(0.141)	-3.049***	(0.945)	0.093	(0.161)	-3.051***	(0.855)
Observations	850		616		850		616	
F (15,834)	15.84***				4.84***			
Wald chi2 (30)			210.20***				209.61***	
Pseudo R2			0.417				0.420	

Note: 1. *, **, and *** Indicate significance level at 10%, 5%, and 1%, respectively.

2. Computed by the authors using 2017 survey data.

A.3.3 Result of a Valid Instrumental Variable for AC Credit Participation

Independent Variables	Dependent Variables			
	Oth_loan (EEV)		AC Credit Participation (Y/N)	
	Coefficient	R.S.E	Coefficient	R.S.E
<i>Individual Characteristics</i>				
Age_Yr	33.945	(566.343)	-0.012	(0.011)
Edu_Yr	6,607.506	(6,016.679)	-0.062**	(0.029)
<i>Household Characteristics</i>				
Farm_Mem			0.004	(0.109)
Farm_Si	601.953**	(236.719)	0.017**	(0.008)
Farm_Sq			-0.00009**	(0.00004)
Farm_Ass	-28,002.07	(26,526.93)	-0.490*	(0.252)
Land	-55,959.3	(57,886.6)		
Tot_Inc	0.005	(0.010)		
Ext_Acc	18,509.06	(12,641.54)	0.397*	(0.203)
Oth_loan			-4.42e-07	(3.94e-07)
OthMem_Cre (IV)	45,546.94**	(18,991.02)	-0.256	(0.266)
<i>Household Perception</i>				
Pro_Risk	-2,507.277	(5,128.01)	0.021	(0.120)
Mkt_Risk	-621.513	(5,373.409)	0.083	(0.775)
Fin_Risk	11,975.65**	(5,859.392)	-0.040	(0.096)
CreAcc_Be			-0.152	(0.110)
IncGen_Be			0.137	(0.091)
<i>Geographical and Related Factors</i>				
Dis_Town	-210.810	(577.903)	0.041***	(0.014)
Dist_N			-0.212	(0.224)
Dist_S			0.308	(0.276)
Comm_Att			0.155**	(.074)
Constant	-16,395.85	(44,444.04)	1.405	(1.028)
Observations	492		Observations	487
F(12, 479)	2.11**		Wald chi2 (18)	38.27***
			Pseudo R ²	0.1765

Note: 1. *, **, and *** Indicate significance level at 10%, 5%, and 1%, respectively.

2. Computed by the authors using 2017 survey data.

A.3.4 Result of Endogeneity Problem in AC Credit Participation

Independent Variables	Dependent Variables			
	Oth_loan (EEV)		AC Credit Participation (Y/N)	
	Coefficient	R.S.E	Coefficient	R.S.E
<i>Individual Characteristics</i>				
Age_Yr	33.95	(566.34)	-0.013	(0.011)
Edu_Yr	6,607	(6,016)	-0.051	(0.033)
<i>Household Characteristics</i>				
Farm_Mem			0.003	(0.107)
FarmSi_Aft	601.95**	(236.72)	0.018**	(0.009)
Farm_Sq			-9.47e-05**	(3.82e-05)
Farm_Ass	-28,002	(26,526)	-0.547*	(0.283)
Land	-55,959	(57,886)		
Tot_Inc	0.005	(0.010)		
Ext_Acc	18,509	(12,642)	0.423*	(0.220)
Oth_loan			-2.19e-06	(3.63e-06)
OthMem_Cre (IV)	45,547**	(18,991)		
<i>Household Perception</i>				
Pro_Risk	-2,507	(5,128)	-0.008	(0.118)
Mkt_Risk	-621.51	(5,373)	0.085	(0.109)
Fin_Risk	11,975**	(5,859)	-0.020	(0.107)
CreAcc_be			-0.167	(0.110)
IncGen_be			0.142	(0.089)
<i>Geographical and Related Factors</i>				
Dis_Town	-210.81	(577.90)	0.040***	(0.014)
Dist_N			-0.225	(0.224)
Dist_S			0.326	(0.226)
Comm_Att			0.155**	(0.074)
Res(Oth_loan)			1.74e-06	(3.67e-06)
Constant	-16396	(44,444)	1.346	(1.000)
Observations	492		Observations	487
F(12, 479)	2.11**		Wald chi2 (18)	38.56***
			Pseudo R ²	0.1733

Note: 1. *, **, and *** Indicate significance level at 10%, 5%, and 1%, respectively.

2. Computed by the authors using 2017 survey data.

A.4 Result of a Valid Instrumental Variable for AC Credit Model (Heckman Selection Model)

Independent Variables	AC credit Participation (Y/N)		Independent Variables	AC Loan size (log)	
	Coefficient	R.S.E		Coefficient	Coefficient
<i>Individual Characteristics</i>					
Age_Yr	-0.013	(0.011)	lgAge	0.122	(0.259)
Edu_Yr	-0.061**	(0.030)	lgEdu	0.157	(0.102)
			Paddy	0.045	(0.100)
			Orchard	0.086	(0.146)
			Cash_Crop	0.289***	(0.110)
<i>Household Characteristics</i>					
Farm_Mem	0.003	(0.106)	lgFarm_Mem	0.080	(0.093)
FarmSi_Aft	0.017**	(0.008)	lgFarm_Size	0.161***	(0.055)
Farm_Sq	-9.47e-05**	(3.81e-05)			
Farm_Ass	-0.506**	(0.252)			
Oth_loan	-4.94e-07	(4.04e-07)			
Ext_Acc	0.393*	(0.204)			
<i>Household Perception</i>					
Pro_Risk	-0.010	(0.118)	Pro_Risk	-0.007	(0.050)
Mkt_Risk	0.093	(0.112)	Mkt_Risk	-0.035	(0.050)
Fin_Risk	-0.044	(0.096)	Fin_Risk	-0.103**	(0.043)
CreAcc_be	-0.169	(0.111)			
IncGen_be	0.147	(0.091)			
<i>AC Credit Attributes</i>					
			lgAC_Share	0.141***	(0.037)
			ACdur_Med	0.647***	(0.170)
			ACdur_Long	0.708***	(0.140)
			Coll_prop	0.397***	(0.090)
<i>Geographical and Related Factors</i>					
Dis_Town	0.041***	(0.014)			
Dist_N	-0.234	(0.232)	Dist_N	0.424***	(0.112)
Dist_S	0.317	(0.273)	Dist_S	0.379***	(0.096)
Comm_Att (IV)	0.153**	(0.074)	Comm_Att	0.015	(0.026)
Constant	1.399	(1.019)	Constant	8.412***	(1.130)
Observations	487		Observations	422	
Wald chi2	37.96***		LR chi2 (17)	133.72***	
Pseudo R2	0.173				

Note: 1. *, **, and *** Indicate significance level at 10%, 5%, and 1%, respectively.

2. Computed by the authors using 2017 survey data.

A.5 Result of a Valid Instrumental Variable for AC Input Marketing Model (Heckman Selection Model)

Independent Variables	AC Input Marketing Participation (Y/N)		Independent Variables	AC Input Expenditure (log)	
	Coefficient	R.S.E		Coefficient	R.S.E
Individual Characteristics					
Age_Yr	0.003	(0.007)	lgAge	-0.197	(0.284)
Edu_Yr	0.034*	(0.020)			
Paddy	-0.105	(0.181)			
Cash_Crop	-0.507***	(0.191)			
Orchard	-0.491	(0.318)			
Household Characteristics					
Farm_Si	0.016***	(0.005)	lgFarm_Size	0.494***	(0.119)
Farm_Sq	-5.01e-05*	(2.88e-05)			
Farm_Mem	-0.051	(0.068)	lgFarm_Mem	0.050	(0.149)
Irr_Acc	-0.331	(0.207)			
Tech_Acc	0.489**	(0.202)			
FarmRev_Aft	-1.28e-07	(1.32e-07)	lgFarm_Inc	0.202***	(0.075)
Household Perception					
Pro_Risk	-0.051	(0.080)	Pro_Risk	-0.150**	(0.072)
Mkt_Risk	0.058	(0.086)	Mkt_Risk	0.110	(0.074)
Fin_Risk	-0.077	(0.072)	Fin_Risk	-0.005	(0.063)
Inp_Acc (IV)	0.169***	(0.063)	Inp_Acc	0.040	(0.061)
AC Input Marketing Attributes					
			lgAC_Share	0.068	(0.042)
			ACInp_cre	0.272**	(0.129)
Geographical and Related Factors					
Dist_N	-0.891***	(0.186)	Dist_N	-0.189	(0.146)
Dist_S	-0.594***	(0.176)	Dist_S	0.206	(0.145)
AC_Vill	0.449**	(0.176)	ACdis	0.008	(0.006)
Comm_Att	0.088**	(0.043)			
Constant	-0.762	(0.628)	Constant	5.414***	(1.273)
Observations	516		Observations	214	
Wald chi2	66.13***		LR chi2 (13)	121.08***	
Pseudo R2	0.106				

Note: 1. *, **, and *** Indicate significance level at 10%, 5%, and 1%, respectively.

2. Computed by the authors using 2017 survey data.

A.6 Result of a Valid Instrumental Variable for AC Output Marketing Model (Heckman Selection Model)

Independent Variables	AC Output Marketing Participation (Y/N)		Independent Variables	AC Sale Quantity (log)	
	Coefficient	R.S.E.		Coefficient	R.S.E.
Individual Characteristics					
Age_Yr	0.006	(0.008)	lgAge	-0.127	(0.664)
Edu_Yr	0.022	(0.024)	lgEdu_Adj	0.196	(0.259)
Paddy	0.456**	(0.221)	Paddy	-0.201	(0.302)
Cash_Crop	0.166	(0.216)	Cash_Crop	-0.087	(0.368)
Orchard	0.227	(0.288)	Orchard	-1.334***	(0.416)
Househol Characteristics					
Farm_Mem	0.103	(0.083)			
FarmSi_Aft	0.017**	(0.007)	lgFarm_Size	0.770***	(0.129)
Farm_Sq	-7.04e-05**	(3.41e-05)			
Commer	-0.443	(0.408)	Commer	1.949***	(0.722)
Cre_use	0.360	(0.232)			
FarInc_PU	-0.010	(0.218)			
Household Perception					
Pro_Risk	-0.063	(0.097)	Pro_Risk	-0.038	(0.120)
Mkt_Risk	-0.095	(0.099)	Mkt_Risk	-0.141	(0.142)
Fin_Risk	-0.189**	(0.088)	Fin_Risk	0.087	(0.113)
Out_Acc	0.366***	(0.089)	Out_Acc	-0.052	(0.122)
Inf_Acc	-0.016	(0.064)			
Attributes of AC Output Marketing Service					
			lgAC_Share	0.072	(0.072)
			AC_P	-0.165***	(0.051)
			AC_Pay	0.204	(0.311)
			AC_Othsale	-0.491**	(0.195)
Geographical and Related Factors					
Dist_N	0.047	(0.211)	Dist_N	0.437	(0.388)
Dist_S	0.760***	(0.222)	Dist_S	0.401	(0.330)
ACdis_n	-0.018***	(0.007)			
Constant	-2.780***	(0.952)	Constant	6.050**	(2.902)
Observations	460		Observations	95	
Wald chi2 (19)	55.67***		LR chi2(17)	92.92***	
Pseudo R2	0.132				

Note: 1. *, **, and *** Indicate significance level at 10%, 5%, and 1%, respectively.

2. Computed by the authors using 2017 survey data.

A.7 Heteroskedasticity Test Results

	Participation Equation in AC and AC services (equation 5.1)					Participation Level Equation in AC services (equation 5.2)		
	Membership	Credit	Input marketing	Output marketing	Agricultural Extension Services	Credit	Input marketing	Output marketing
Breusch-Pagan/Cook-Weisberg	101.91	151.65	7.73	48.01	50.39	42.27	12.9	50.37
Reject/not reject H0	Reject at 1%	Reject at 1%	Not reject	Reject at 1%	Reject at 1%	Reject at 1%	Not reject	Reject at 1%

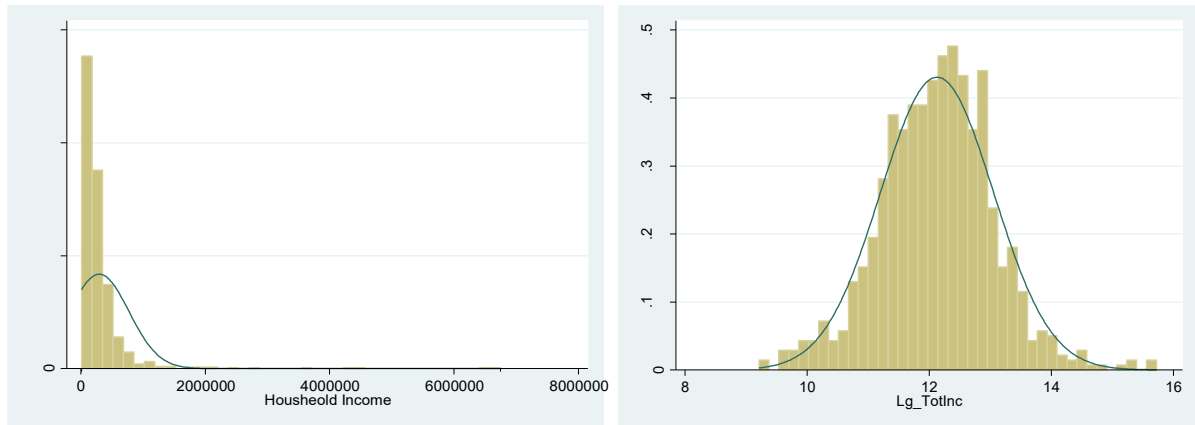
Note: 1. number in parentheses are the probability > chi2 for BP/CW test

2. Computed by the authors using 2017 survey data.

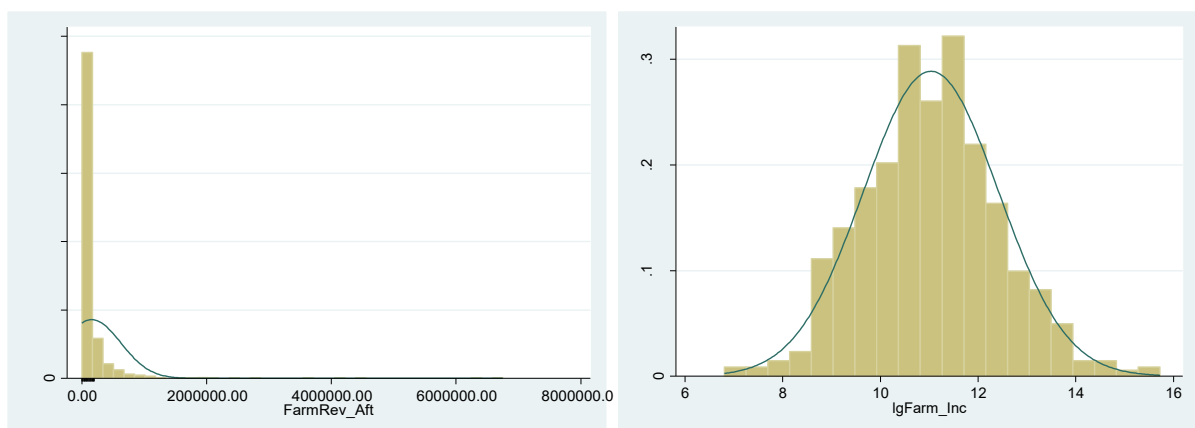
Appendix B: Effects of AC Service Participation

B.1 Distribution of Household Welfare Indicators

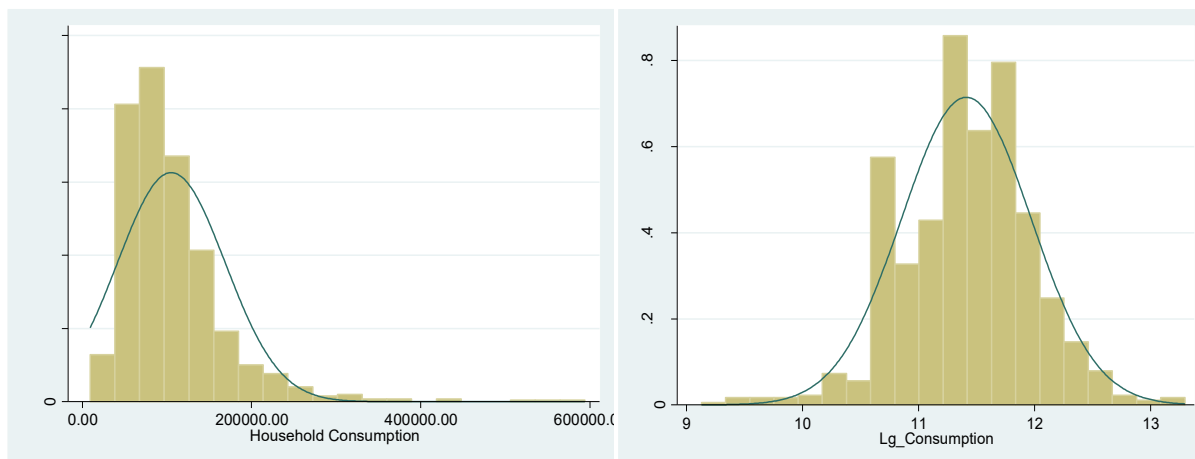
B.1.1 Distribution of Household Income and Log of Household Income



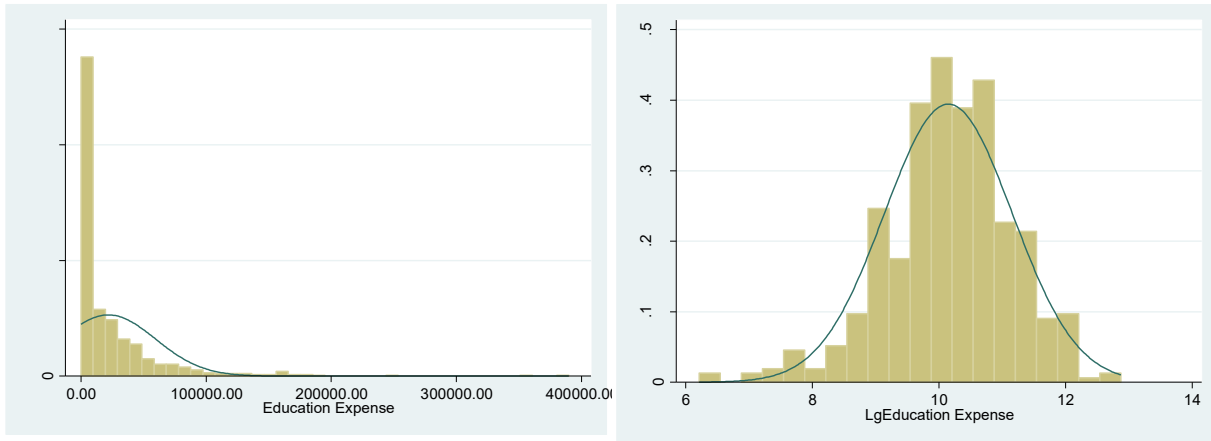
B.1.2 Distribution of Household Farm Income and Log of Household Farm Income



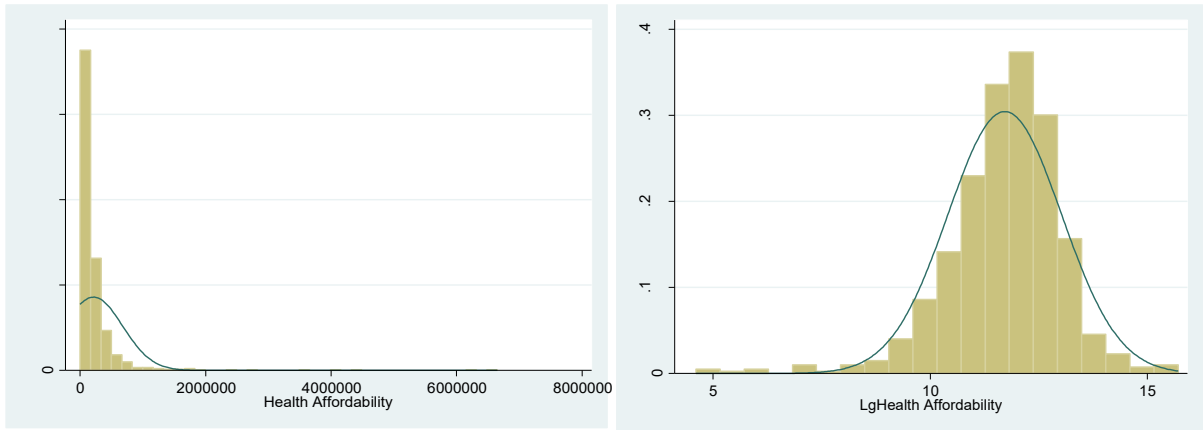
B.1.3 Distribution of Household Consumption and Log of Household Consumption



B.1.4 Distribution of Household Education Expense and Log of Household Education Expense



B.1.5 Distribution of Household Health Affordability and Log of Household Health Affordability



B.2 Result of a Valid Instrumental Variable for Household Income Model

Variables	AC credit		AC Marketing service	
	Paritipation (Y/N)	Lg_TotInc	Paritipation (Y/N)	Lg_TotInc
<i>Individual Characteristics</i>				
IgAge	-0.075 (0.288)	0.014 (0.123)	0.113 (0.284)	0.150 (0.123)
IgEdu_Adj	-0.128 (0.127)		0.072 (0.141)	
Paddy	-0.446** (0.174)	-0.322*** (0.077)	-0.129 (0.153)	-0.320*** (0.080)
Orchard	-0.249 (0.243)	0.323*** (0.116)	-0.189 (0.231)	0.397*** (0.149)
Cash_Crop	0.319* (0.166)	0.057 (0.072)	-0.037 (0.148)	0.056 (0.073)
<i>Household Characteristics</i>				
IgHHmem	-0.220 (0.134)	0.571*** (0.062)	-0.181 (0.130)	0.516*** (0.064)
Dep_Rat	-0.114 (0.081)	-0.078** (0.036)	0.097 (0.071)	-0.045 (0.037)
IgFarm_Size	0.229*** (0.074)	0.414*** (0.033)	0.411*** (0.070)	0.432*** (0.038)
Farm_Ass	-0.170 (0.118)	-0.061 (0.055)	0.148 (0.114)	-0.078 (0.053)
Land	-0.409** (0.180)	0.055 (0.082)	-0.006 (0.166)	0.022 (0.080)
Off_Farm			0.066 (0.119)	0.366*** (0.064)
Commer	0.094 (0.130)	0.250*** (0.071)	-0.174 (0.174)	0.234*** (0.070)
Other Loan	-1.73e-07 (2.96e-07)	4.30e-07*** (1.63e-07)	0.383*** (0.130)	0.087 (0.059)
Cre_Use				
Ext_Acc	0.804*** (0.122)		0.376*** (0.122)	
Irr_Acc	-0.116 (0.111)	0.101* (0.052)		
<i>Household Perception</i>				
Pro_Risk	-0.076 (0.072)	0.057* (0.033)	-0.072 (0.068)	0.035 (0.033)
Mkt_Risk	-0.015 (0.077)	-0.086** (0.036)	0.113 (0.074)	-0.066* (0.039)
Fin_Risk	0.236*** (0.062)	-0.211*** (0.029)	-0.001 (0.062)	-0.210*** (0.029)

B.2 Result of a Valid Instrumental Variable for Household Income Model (cont.)

Variables	AC credit		AC Marketing service	
	Paritipation (Y/N)	Lg_TotInc	Paritipation (Y/N)	Lg_TotInc
<i>Geographical and Related Factors</i>				
lgDis	0.291*** (0.056)			
Dist_N	0.333** (0.144)		-0.205 (0.132)	
Dist_S	-0.162 (0.151)		-0.320** (0.133)	
AC_Vill	0.607*** (0.175)	-0.045 (0.076)	0.584*** (0.156)	
AC_Rela	0.946*** (0.148)		0.656*** (0.163)	0.101 (0.070)
Comm_Att	0.254*** (0.032)		0.186*** (0.032)	
Constant	-2.254 (1.383)	10.72*** (0.536)	-3.658*** (1.416)	
Observations	839		839	
Wald chi2	258.79***		162.16***	
Pseudo R2	0.3158		0.1867	
F-test		37.23***		43.80***

Note: 1. *, **, and *** Indicate significance level at 10%, 5%, and 1%, respectively.

2. Robust Standard Errors are in the brackets

3. Computed by the authors using 2017 survey data.

B.3 Result of a Valid Instrumental Variable for Farm Income Model

Variables	AC credit		AC Marketing Service	
	Participation (Y/N)	Lg_FarmInc	Participation (Y/N)	Lg_FarmInc
<i>Individual Characteristics</i>				
lgAge	-0.030 (0.284)	-0.450 (0.418)	0.218 (0.276)	-0.219 (0.333)
lgEdu_Adj	-0.143 (0.128)	-0.191 (0.193)	0.100 (0.138)	-0.082 (0.356)
Paddy	-0.408** (0.175)	-0.026 (0.341)	-0.153 (0.155)	0.963*** (0.362)
Orchard	-0.214 (0.243)	0.881** (0.368)	-0.199 (0.238)	0.423 (0.500)
Cash_Crop	0.317* (0.167)	0.444 (0.505)	-0.054 (0.150)	0.075 (0.200)
<i>Household Characteristics</i>				
lgFarm_Mem	0.073 (0.134)	0.102 (0.198)	0.087 (0.128)	1.279*** (0.221)
lgFarm_Size	0.183*** (0.071)	1.316*** (0.239)	0.404*** (0.069)	
Land	-0.420** (0.180)	0.024 (0.230)		
Oth_loan	-1.77e-07 (3.03e-07)	5.12e-07 (4.17e-07)	0.374*** (0.129)	0.309 (0.203)
Cre_Use				
Ext_Acc	0.767*** (0.121)		0.367*** (0.120)	
Irr_Acc	-0.175 (0.175)	0.099 (0.221)	-0.264 (0.183)	0.141 (0.220)
Tech_Acc	0.026 (0.171)	-0.151 (0.228)	0.363** (0.179)	-0.154 (0.227)
Commer	0.102 (0.128)	4.923** (2.410)	-0.178 (0.164)	4.930** (2.401)
<i>Household Perception</i>				
Pro_Risk	-0.059 (0.071)	-0.121 (0.101)	-0.079 (0.067)	-0.128 (0.102)
Mkt_Risk	-0.003 (0.077)	0.031 (0.118)	0.108 (0.073)	0.037 (0.119)
Fin_Risk	0.208*** (0.061)	-0.176* (0.100)	0.015 (0.060)	-0.175* (0.101)

B.3 Result of a Valid Instrumental Variable for Farm Income Model (cont.)

Variables	AC credit		AC Marketing Service	
	Participation (Y/N)	Lg_FarmInc	Participation (Y/N)	Lg_FarmInc
<i>Geographical and Related Factors</i>				
lgDis	0.294*** (0.055)			
Dist_N	0.308** (0.143)	0.066 (0.208)	-0.200 (0.132)	
Dist_S	-0.136 (0.150)	0.247 (0.228)	-0.318** (0.133)	
AC_Vill	0.594*** (0.172)	-0.518 (0.357)	0.586*** (0.159)	-0.541 (0.361)
AC_Rela	0.969*** (0.147)		0.632*** (0.163)	
Comm_Att	0.252*** (0.031)		0.186*** (0.031)	
Constant	-2.788** (1.347)	5.739** (2.753)	-4.208*** (1.354)	4.532** (2.190)
Observations	837		837	
Wald chi2	244.75***		168.75***	
Pseudo R2	0.3077		0.1862	
F-test		44.70***		57.51***

Note: 1. *, **, and *** Indicate significance level at 10%, 5%, and 1%, respectively.
2. Robust Standard Errors are in the brackets
3. Computed by the authors using 2017 survey data.

B.4 Result of a Valid Instrumental Variable for Household Consumption Model

Variables	AC credit		AC Marketing Services	
	Participation (Y/N)	Lg_Cons	Participation (Y/N)	Lg_Cons
<i>Individual Characteristics</i>				
lgAge	-0.156 (0.288)	-0.454*** (0.098)	0.153 (0.286)	-0.459*** (0.086)
lgEdu	-0.166 (0.124)	0.0863 (0.050)	0.099 (0.142)	
Paddy			-0.124 (0.154)	-0.087 (0.053)
Cash_Crop			-0.072 (0.153)	0.028 (0.049)
Orchard			-0.164 (0.233)	0.109 (0.075)
<i>Household Characteristics</i>				
lgHHmem	-0.234* (0.132)	0.498*** (0.046)	-0.185 (0.130)	0.486*** (0.045)
Dep_Rat	-0.093 (0.078)	-0.027 (0.024)	0.101 (0.072)	-0.019 (0.024)
lgFarm_Size	0.340*** (0.066)		0.429*** (0.068)	0.054** (0.022)
Farm_Ass	-0.157 (0.116)			
Land	-0.467*** (0.175)		-0.014 (0.166)	0.104* (0.062)
Oth_loan ,Cred_use	-9.98e-08 (2.87e-07)	4.15e-07*** (1.04e-07)	0.380*** (0.130)	0.124*** (0.042)
Ext_Acc	0.811*** (0.117)		0.383*** (0.122)	
Tech_Acc	-0.118 (0.104)	-0.050 (0.035)		
Off_Farm	0.108 (0.119)	0.083** (0.039)	0.076 (0.118)	0.102** (0.039)
Commer			-0.181 (0.185)	
<i>Household Perception of Risks</i>				
Pro_Risk	-0.092 (0.070)	0.038* (0.022)	-0.085 (0.068)	0.034 (0.022)
Mkt_Risk	0.009 (0.075)	-0.023 (0.025)	0.109 (0.074)	-0.023 (0.024)
Fin_Risk	0.232*** (0.061)	-0.008 (0.019)	0.009 (0.061)	-0.022 (0.019)

B.4 Result of a Valid Instrumental Variable for Household Consumption Model (cont.)

Variables	AC credit		AC Marketing Services	
	Participation (Y/N)	Lg_Con	Participation (Y/N)	Lg_Con
<i>Geographical and Related Factors</i>				
lgDis	0.369*** (0.053)		0.063 (0.053)	
Dist_N	0.087 (0.130)		-0.218 (0.134)	
Dist_S	-0.166 (0.139)		-0.335** (0.133)	
AC_Rela	0.946*** (0.144)	0.047 (0.041)	0.630*** (0.165)	-0.027 (0.043)
AC_Vill	0.591*** (0.166)		0.599*** (0.155)	
Comm_Att	0.253*** (0.031)		0.179*** (0.031)	
Constant	-2.420* (1.373)	12.29*** (0.477)	-3.869*** (1.437)	12.29*** (0.386)
Observations	844	850	839	844
Wald chi2	247.92***		159.85***	
Pseudo R2	0.2970		0.1863	
F-test		22.46***		20.36***

Note: 1. *, **, and *** Indicate significance level at 10%, 5%, and 1%, respectively.
2. Robust Standard Errors are in the brackets
3. Computed by the authors using 2017 survey data.

B.5 Result of a Valid Instrumental Variable for Educational Expenditure Model

Variables	AC Credit		AC Marketing Services	
	Participation (Y/N)	LgEdu_Exp	Participation (Y/N)	LgEdu_Exp
<i>Individual Characteristics</i>				
lgAge	-0.024 (0.405)	0.393 (0.367)	0.286 (0.407)	0.386 (0.374)
lgEdu_Adj	-0.208 (0.196)	0.417** (0.171)	-0.186 (0.205)	0.464*** (0.175)
Paddy	-0.496** (0.238)			
Orchard	-0.850** (0.368)			
Cash_Crop	0.045 (0.227)			
<i>Household Characteristics</i>				
lgHHmem	0.066 (0.258)	0.576*** (0.191)	-0.747*** (0.265)	0.578*** (0.191)
Dep_Rat	-0.131 (0.110)	0.053 (0.066)	0.032 (0.100)	0.061 (0.067)
lgFarm_Size	0.266*** (0.095)	0.042 (0.066)	0.431*** (0.089)	0.035 (0.067)
Oth_loan, Cre_use	1.89e-07 (3.03e-07)	5.55e-07*** (2.12e-07)	0.131 (0.183)	0.198 (0.143)
Ext_Acc	0.709*** (0.185)		0.438** (0.188)	
Land				0.270 (0.206)
<i>Household Perception of Risks</i>				
Pro_Risk	-0.135 (0.103)		-0.288*** (0.105)	
Mkt_Risk	-0.015 (0.114)		-0.009 (0.121)	
Fin_Risk	0.141* (0.083)		-0.058 (0.087)	

B.5 Result of a Valid Instrumental Variable for Educational Expenditure Model (cont.)

Variables	AC Credit		AC Marketing Services	
	Participation (Y/N)	LgEdu_Exp	Participation (Y/N)	LgEdu_Exp
<i>Geographical and Related Factors</i>				
lgDis	0.215*** (0.078)			
Dist_N			-0.281 (0.184)	
Dist_S			-0.622*** (0.201)	
AC_Rela	0.780*** (0.206)	-0.188 (0.139)	0.928*** (0.236)	
AC_Vill	0.783*** (0.244)		0.638*** (0.230)	-0.086 (0.171)
Comm_Att	0.265*** (0.047)		0.162*** (0.047)	
Constant	-2.261 (1.928)	6.538*** (1.712)	-1.887 (2.028)	5.985*** (1.722)
Observations	379		379	
Wald chi2	117.06***		89.69***	
Pseudo R2	0.2748		0.2104	
F-test		4.78***		2.85**

Note: 1. *, **, and *** Indicate significance level at 10%, 5%, and 1%, respectively.
2. Robust Standard Errors are in the brackets
3. Computed by the authors using 2017 survey data.

B.6 Result of a Valid Instrumental Variable for Health Affordability Model

Variables	AC Credit		AC Marketing Services	
	Participation (Y/N)	Lg_Hea_Aff	Participation (Y/N)	Lg_Hea_Aff
<i>Individual Characteristics</i>				
IgAge	-0.074 (0.287)	1.633** (0.758)	0.064 (0.282)	1.628** (0.755)
IgEdu	-0.122 (0.127)	0.172 (0.379)	0.038 (0.141)	0.214 (0.389)
Paddy	-0.469*** (0.171)	-0.969** (0.415)	-0.135 (0.154)	-0.735* (0.404)
Orchard	-0.279 (0.237)	0.348 (0.765)	-0.237 (0.232)	0.133 (0.748)
Cash_Crop	0.319* (0.165)	0.020 (0.440)	-0.055 (0.148)	-0.048 (0.413)
<i>Household Characteristics</i>				
IgHHmem	-0.229* (0.134)	0.775** (0.359)	-0.179 (0.127)	0.775* (0.360)
Dep_Rat	-0.119 (0.081)	-0.146 (0.219)	0.097 (0.071)	-0.118 (0.217)
IgFarm_Size	0.230*** (0.074)	1.710*** (0.216)	0.405*** (0.070)	1.768*** (0.216)
Sav	-0.082 (0.113)	0.941*** (0.308)	0.222** (0.107)	0.944*** (0.306)
Farm_Ass	-0.173 (0.117)	-0.571* (0.343)	0.146 (0.114)	-0.561 (0.345)
Land	-0.388** (0.180)	-0.850* (0.448)	-0.033 (0.167)	-0.724* (0.438)
Oth_loan	-1.83e-07		0.392***	0.483
, Cre_Use	(2.94e-07)		(0.130)	(0.375)
Ext_Acc	0.800*** (0.122)		0.384*** (0.122)	
Commer	0.083 (0.129)	1.131** (0.510)	-0.140 (0.170)	1.051** (0.480)
<i>Household Perception of Risks</i>				
Pro_Risk	-0.060 (0.075)	-0.183 (0.191)	-0.097 (0.069)	-0.172 (0.190)
Mkt_Risk	-0.012 (0.078)	-0.179 (0.255)	0.101 (0.075)	-0.191 (0.256)
Fin_Risk	0.227*** (0.063)	-0.824*** (0.190)	0.016 (0.063)	-0.853*** (0.190)

B.6 Result of a Valid Instrumental Variable for Health Affordability Model (cont.)

Variables	AC Credit		AC Marketing Services	
	Participation (Y/N)	Lg_Hea_Aff	Participation (Y/N)	Lg_Hea_Aff
<i>Geographical and Related Factors</i>				
IgDis	0.291*** (0.056)			
Dist_N	0.355** (0.144)	-0.041 (0.400)	-0.232* (0.132)	
Dist_S	-0.161 (0.150)	-0.790* (0.412)	-0.340** (0.134)	
AC_Rela	0.934*** (0.147)		0.658*** (0.161)	
AC_Vill	0.596*** (0.173)	-0.326 (0.465)	0.555*** (0.157)	-0.341 (0.464)
Comm_Att	0.250*** (0.033)		0.199*** (0.033)	
Constant	-2.268 (1.388)	1.680 (3.634)	-3.419*** (1.409)	0.681 (3.70)
Observations	839		839	
Wald chi2	249.91***		158.65***	
Pseudo R2	0.3153		0.1903	
F-test		11.46***		12.02***

Note: 1. *, **, and *** Indicate significance level at 10%, 5%, and 1%, respectively.
2. Robust Standard Errors are in the brackets
3. Computed by the authors using 2017 survey data.

B.7 Result of a Valid Instrumental Variable for School Enrolment Model

Variables	AC Credit		AC Marketing Services	
	Participation (Y/N)	Sch_Enr (Y/N)	Participation (Y/N)	Sch_Enr (Y/N)
<i>Individual Characteristics</i>				
Age_Yr	0.124** (0.052)	0.027*** (0.009)		0.026*** (0.009)
Age_Sq	-0.001** (0.0005)			
Edu_Yr	-0.020 (0.023)	0.018 (0.027)	-0.026 (0.021)	0.018 (0.027)
<i>Household Characteristics</i>				
Hhmem	0.035 (0.054)	-0.275*** (0.056)	-0.120** (0.055)	-0.259*** (0.057)
Dep_Rat	-0.0043 (0.114)	-0.561*** (0.107)	0.068 (0.099)	-0.581*** (0.107)
Farm_Si	0.014** (0.006)		0.019*** (0.006)	-0.001 (0.003)
Farm_Sq	-4.76e-05 (2.94e-05)		-7.64e-05** (3.81e-05)	
Inc_PU	-0.172 (0.200)	0.076 (0.209)		0.076 (0.214)
Oth_loan, Cre_use	1.04e-07 (2.65e-07)	1.58e-06 (1.13e-06)	0.168 (0.180)	0.047 (0.198)
Ext_Acc	0.661*** (0.179)		0.408** (0.186)	
Land				0.319 (0.237)
<i>Household Perception of Risks</i>				
Pro_Risk	-0.106 (0.099)		-0.262*** (0.100)	
Mkt_Risk	-0.025 (0.111)		0.004 (0.119)	
Fin_Risk	0.107 (0.082)		-0.045 (0.086)	

B.7 Result of a Valid Instrumental Variable for School Enrolment Model (cont.)

Variables	AC Credit		AC Marketing Services	
	Participation (Y/N)	Sch_Enr (Y/N)	Participation (Y/N)	Sch_Enr (Y/N)
<i>Geographical and Related Factors</i>				
Dis_Town	0.024*** (0.008)			
Dist_N			-0.273 (0.181)	
Dist_S			-0.614*** (0.193)	
AC_Rela	0.906*** (0.205)	-0.307 (0.250)	0.911*** (0.251)	
AC_Vill	0.775*** (0.234)		0.645*** (0.223)	0.017 (0.230)
Comm_Att	0.249*** (0.045)		0.152*** (0.046)	
Constant	-5.536*** (1.513)	1.492** (0.654)	-0.768 (0.634)	1.016 (0.652)
Observations	380	380	380	381
Wald chi2	111.93***	52.40***	70.22***	55.34***
Pseudo R2	0.2504	0.1770	0.1825	0.1683

Note: 1. *, **, and *** Indicate significance level at 10%, 5%, and 1%, respectively.
2. Robust Standard Errors are in the brackets
3. Computed by the authors using 2017 survey data.

B.8 Result of a Valid Instrumental Variable for Adoption of Improved Farm Technologies and Practice Model

Variables	AC Credit		AC Agricultural Extension Services	
	Participation (Y/N)	Farm_Adoption (Y/N)	Participation (Y/N)	Farm_Adoption (Y/N)
<i>Individual Characteristics</i>				
Age_Yr	0.084** (0.035)	0.051 (0.037)	0.087** (0.038)	0.045 (0.038)
Age_Sq	-0.0008** (0.0003)	-0.0004 (0.0003)	-0.0008** (0.0003)	-0.0004 (0.0004)
Edu_Yr	-0.024 (0.017)	0.030* (0.018)	0.005 (0.017)	0.039** (0.019)
Sex	-0.162 (0.107)	-0.094 (0.108)	-0.248** (0.108)	-0.019 (0.111)
Paddy	-0.418*** (0.161)		-0.357** (0.161)	
Orchard	-0.050 (0.231)		-0.484** (0.232)	
Cash_Crop	0.491*** (0.153)		0.524*** (0.154)	
<i>Household Characteristics</i>				
Farm_Mem	-0.0008 (0.062)	-0.048 (0.059)	0.105* (0.056)	-0.025 (0.063)
Farm_Si	0.012** (0.005)	-0.002 (0.002)	0.001 (0.005)	-0.0001 (0.002)
Farm_Sq	-5.30e-05** (2.61e-05)		-1.61e-05 (2.63e-05)	
Sav	-0.239** (0.103)	0.123 (0.103)	-0.031 (0.104)	0.183* (0.107)
Farm_Ass	-0.228** (0.110)		-0.164 (0.108)	-0.651*** (0.121)
Land	-0.291* (0.176)	-0.048 (0.165)	0.135 (0.179)	-0.072 (0.168)
Inc_PU	-0.115 (0.125)	-0.093 (0.126)	-0.064 (0.132)	-0.061 (0.132)
Oth_loan, Cre_use	-2.75e-07 (2.99e-07)		0.984*** (0.123)	0.243** (0.124)
Ext_Acc	0.730*** (0.117)			
Irr_Acc		-0.093 (0.108)		-0.075 (0.111)
Off_Farm		-0.132 (0.123)	0.141 (0.122)	-0.132 (0.127)

B.8 Result of a Valid Instrumental Variable for Adoption of Improved Farm Technologies and Practice Model (cont.)

Variables	AC Credit		AC Agricultural Extension Services	
	Participation (Y/N)	Farm_Adoption (Y/N)	Participation (Y/N)	Farm_Adoption (Y/N)
<i>Household Perception of Risks</i>				
Pro_Risk	-0.034 (0.069)		0.059 (0.069)	
Mkt_Risk	-0.049 (0.072)		-0.031 (0.075)	
Fin_Risk	0.201*** (0.058)		0.153** (0.064)	
Weath		-0.011 (0.059)		-0.022 (0.059)
Pest		0.086 (0.052)		0.080 (0.052)
Soil		0.086* (0.046)		0.076* (0.045)
Qual		0.082* (0.044)		0.079* (0.045)
<i>Geographical and Related Factors</i>				
Dis_Town	0.020*** (0.005)			
Dist_N	0.403*** (0.134)	-0.098 (0.133)	0.439*** (0.135)	-0.102 (0.136)
Dist_S	-0.121 (0.141)	-0.247* (0.137)	0.129 (0.140)	-0.291** (0.141)
AC_Rela	1.097*** (0.138)	0.076 (0.131)	1.035*** (0.145)	0.052 (0.137)
AC_Vill			0.732*** (0.177)	
Constant	-3.419*** (1.075)	-1.062 (1.070)	-4.695*** (1.135)	-0.753 (1.118)
Observations	850	850	850	850
Wald chi2	232.87***	37.18***	212.38***	69.00***
Pseudo R2	0.252	0.043	0.268	0.082

Note: 1. *, **, and *** Indicate significance level at 10%, 5%, and 1%, respectively.
2. Robust Standard Errors are in the brackets
3. Computed by the authors using 2017 survey data.

B.9 Result of a Valid Instrumental Variable for Household Health Accessibility Model

Variables	AC Credit		AC Marketing Services	
	Participation (Y/N)	Health Access (Y/N)	Participation (Y/N)	Health Access (Y/N)
<i>Individual Characteristics</i>				
Age_Yr	-0.223 (0.006)	0.006 (0.005)	0.003 (0.005)	0.002 (0.002)
Edu_Yr	-0.030* (0.017)	0.071*** (0.015)	0.011 (0.017)	0.022*** (0.005)
Paddy	-0.452*** (0.167)	0.474*** (0.161)	-0.097 (0.151)	0.139*** (0.046)
Orchard	-0.199 (0.239)	0.800*** (0.199)	-0.222 (0.146)	0.271*** (0.069)
Cash_Crop	0.480*** (0.161)	0.206 (0.140)	0.027 (0.146)	0.063 (0.042)
<i>Household Characteristics</i>				
Hhmem	-0.045 (0.036)	0.057 (0.035)	-0.038 (0.034)	0.014 (0.010)
Dep_Rat	-0.141* (0.080)	-0.006 (0.069)	0.090 (0.070)	0.004 (0.020)
Farm_Si	0.012*** (0.005)	-0.003 (0.002)	0.018*** (0.005)	-0.0009** (0.0005)
Farm_Sq	-5.58e-05** (2.56e-05)		-7.09e-05*** (2.75e-05)	
Farm_Ass	-0.179 (0.115)		0.189* (0.112)	
Land	-0.333* (0.173)	-0.391** (0.152)	-0.035 (0.166)	
Oth_loan, Cre_Use	-9.47e-08 (2.90e-07)	5.66e-12 (2.71e-07)	0.385*** (0.128)	0.021 (0.033)
Ext_Acc	0.773*** (0.120)		0.356*** (0.120)	
Commer			-0.067 (0.131)	
Inc_PU		0.330*** (0.120)		0.091** (0.036)
<i>Household Perception of Risks</i>				
Pro_Risk	-0.078 (0.071)		-0.058 (0.061)	
Mkt_Risk	-0.011 (0.077)		0.109 (0.073)	
Fin_Risk	0.224*** (0.062)		0.005 (0.061)	

B.9 Result of a Valid Instrumental Variable for Household Health Accessibility Model (cont.)

Variables	AC Credit		AC Marketing Services	
	Participation (Y/N)	Health Access (Y/N)	Participation (Y/N)	Health Access (Y/N)
<i>Geographical and Related Factors</i>				
Dis_Town	0.020*** (0.005)	-0.002 (0.005)		
Dist_N	0.413** (0.142)	-0.279** (0.137)	-0.175 (0.131)	-0.083** (0.039)
Dist_S	-0.183 (0.151)	-0.015 (0.133)	-0.335*** (0.132)	0.012 (0.036)
AC_Rela	1.002*** (0.147)	0.125 (0.128)	0.667*** (0.161)	0.014 (0.036)
AC_Vill	0.570*** (0.173)		0.570*** (0.154)	
Comm_Att	0.255*** (0.031)		0.182*** (0.031)	
Constant	-1.879*** (0.591)	-1.933*** (0.455)	-2.657*** (0.600)	-0.198 (0.130)
Observations	850	850	839	850
Wald chi2	251.74***		147.32***	
Pseudo R2	0.3038		0.1745	
F-test		69.79***		7.68***

Note: 1. *, **, and *** Indicate significance level at 10%, 5%, and 1%, respectively.
2. Robust Standard Errors are in the brackets
3. Computed by the authors using 2017 survey data.

Appendix C: Distribution and Mean Difference Test of Samples

C.1 Distribution of Users and Non-Users by AC service Type

District	Credit				Marketing Services				Agricultural Extension Services			
	User		Non-User		User		Non-User		User		Non-User	
	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
Pakchong	108	23.58	43	10.94	43	16.23	108	18.43	104	21.94	47	12.47
Pakthongchai	32	6.99	95	24.17	30	11.32	97	16.55	40	8.44	87	23.08
Phimai	56	12.23	20	5.09	26	9.81	50	8.53	59	12.45	17	4.51
Nonsong	79	17.25	83	21.12	59	22.26	103	17.58	83	17.51	79	20.95
Dankhunthod	122	26.64	98	24.94	90	33.96	130	22.18	123	25.95	97	25.73
Buayai	61	13.32	54	13.74	17	6.42	98	16.72	65	13.71	50	13.26
Total	458	100.00	393	100.00	265	100.00	586	100.00	474	100.00	377	100.00

Note: Computed by the authors using 2017 survey data.

C.2 Result of the Mean Difference Test of Household Income between Paddy and Non-Paddy Farmer Groups

Two-sample t test with unequal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]
0	207	508,343	59,695	858,855	390,653 626,034
1	644	227,500	8,377	212,584	211,050 243,950
combined	851	295,813	16,350	476,959	263,722 327,904
diff		280,843	60,280		162,026 399,660

diff = mean (0) – mean (1)

t = 4.6590

Ho: diff = 0

Satterthwaite's degrees of freedom = 214.167

Ha: diff < 0

Ha: diff! = 0

Ha: diff > 0

Pr(T < t) = 1.0000

Pr(|T| > |t|) = 0.0000

Pr(T > t) = 0.0000

C.3 Result of the Mean difference Test of Farm Income between Paddy and Non-Paddy Farmer Groups

Two-sample t test with unequal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]
0	207	378,710	59,508	856,167	261,388 496,032
1	644	89,249	6,780	172,050	759,36 102,562
combined	851	159,658	15,913	464,202	128,426 190,891
diff		289,461	59,893		171,397 407,524

diff = mean(0) - mean(1)

t = 4.8330

Ho: diff = 0

Satterthwaite's degrees of freedom = 211.371

Ha: diff < 0

Ha: diff! = 0

Ha: diff > 0

Pr(T < t) = 1.0000

Pr(|T| > |t|) = 0.0000

Pr(T > t) = 0.0000

C.4 Distribution of Average Household and Farm Income by Farm Type

Crop type	Non AC-Member		AC-Member		All Respondents	
	Count	Percentage	Count	Percentage	Count	Percentage
<i>Paddy</i>	254	39.44%	390	60.56%	644	100%
Average Household Income (S.E)	208,174	(204,961)	240,087	(216,739)	227,500	(212,584)
Average Farm Income (S.E)	53,960	(116,502)	112,232	(196,873)	89,249	(172,049)
<i>Cash Crop</i>	52	16.15%	270	83.85%	322	100%
Average Household Income (S.E)	372,852	(364,226)	387,417	(457,335)	385,066	(443,147)
Average Farm Income (S.E)	237,349	(261,131)	273,008	(446,501)	267,249	421,988
<i>Orchard</i>	25	46.30%	29	53.70%	54	100%
Average Household Income (S.E)	662,698	(1,077,415)	726,664	(1,646,148)	697,050	(1,399,388)
Average Farm Income (S.E)	567,124	(1,046,501)	600,012	(1,667,058)	584,786	(1,401,567)
<i>Other Crops</i>	4	28.57%	10	71.43%	14	100%
Average Household Income (S.E)	145,346	(55,145)	212,630	(25,025)	193,406	(24,110)
Average Farm Income (S.E)	69,046	(28,912)	57,690	(25,704)	60,935	(19,592)

Appendix D: Survey Questionnaire

Number: []

Date: []

Survey questionnaire for farm households' participating in credit and non-credit support services of Agricultural Cooperatives (ACs)

Respondent's location: Province:

District:

Town: _____

Village:

Instructions: For each question with brackets provided, please tick your answer(s); otherwise, please follow the instructions given to answer the questions. Your participation is voluntary and your answers will be kept confidential.

Section 1. Accessibility to agricultural cooperatives (ACs)
(for All Respondents)

1. Is there an agricultural cooperative (AC) in your village?
a. Yes [] b. No []
2. Are any of your neighbours, friends, or relatives member of AC(s)?
a. Yes [] b. No []
3. Have you or any of your household members worked as a local government official or agricultural cooperative official?
a. Yes [] b. No []
4. Are you or any of your household members a member of an AC?
a. Yes (please go to Q6) [] b. No (please go to Q5) []
5. What is the reason you choose not to be an AC members? (*You may tick more than one*)
a. Local AC is not available []
b. Expected benefit is questionable []
c. Self-farming condition is lower than requirement of AC []
d. Used to the traditional farming methods []
e. Lack of AC understanding []
f. Lack of trust in AC management []
g. AC services do not meet your need []
h. Other(s), please specify: _____
6. What associations do you belong to beside ACs? (*you may tick more than one*)
a. Credit group [] b. Marketing group []
c. Saving group [] d. Other types of cooperatives []
e. Community group (e.g., group of temple) [] f. Other(s), please specify: _____

Below is a series of statements pertaining to your attitude and perception toward farm risks and ACs. Please tick how strongly you agree or disagree with each of the following statements on a scale of 1 to 5. 1 –you strongly disagree (SD), 5 –you strongly agree (SA).

	(1) SD	(2)	(3) Neutral	(4)	(5) SA
Respondent's attitude toward farm risks					
7. Adverse weather condition such as drought, freezes, or excessive rainfall at harvest or planting means my farm yield or output levels will be lower than projected					
8. Insect pests and disease negatively affect my farm yield and output despite control measures employed					
9. Infertile soil negatively affect my farm yield and output					
10. Failure of equipment and machinery such as an irrigation pump means my farm yield and output levels will be lower than projected					
11. Mechanical failure, failure of technical processes, and not willing to adopt new technology negatively affect my farm yields and outputs					
12. Late delivery of supplies and services negatively affect my farm yields and outputs					
13. Lower sales and prices due to increased numbers of competing growers mean the price I received will be less than expected					
14. Changes in consumer preferences means the price I received will be less than expected					
15. If my products fail to meet the market standards or packaging requirements, the price I received will be less than expected					
16. I lose the market for my products due to a wholesale buyer or processor relocating or closing					
17. Failure to access market information (price and demand movement) means my sale and price I received will be less than expected					
18. Insufficient cash to meet expected obligations, generating lower than expected profits, and losing equity in the farm negatively affect my production					
19. Increased input cost and higher interest rates negatively affect my production					
20. Excessive borrowing, higher cash demand for family needs, and lack of adequate cash or credit reserves negatively affect my production					
21. Failure to fulfil business agreements and contracts often carry a high cost					
22. A lack of people management skills and poor communications events can be devastating to a farm					
Respondent's attitude toward AC benefit and performance					
23. I am satisfied with the overall management of AC					
24. ACs make farm operations more profitable than other alternatives					
25. ACs increase my access to credit					
26. ACs are effective in supporting borrowers to spend loans for income generating activities					

27. ACs can facilitate my access to farm inputs with fair price and standard service (e.g., good quality inputs, adequate supply, and punctual delivery)					
28. ACs can facilitate my access to product markets with fair price and standard service (e.g., accurate measurement and punctual payment,)					
29. ACs assist me to improve my farm production					
30. ACs are effective in introducing new farm technologies					
31. ACs increase my access to market information					
32. My closest networks (parents, relatives, friends, etc.) are satisfied with ACs services or alike					
33. My decision to participate in an AC depends on experiences of neighbours, friends, and relatives					

Next please proceed to Section 2 for AC clients and section 3 for non-AC clients

Section 2 Accessibility to AC credit and non-credit support services (for AC members)

34. How far is your residence to the AC that you are member of? (please specify): _____ km.
35. How many shares do you have in an AC? (please specify): _____ baht
36. How many years have you been an AC member? (please specify): _____ years
37. Which other services offered by the AC did you receive over the last 2 years? (You may tick more than one)
- | | | | |
|------------------------------------|-----|------------------------------------|-----|
| a. Credit in term of cash | [] | b. Credit in term of noncash | [] |
| c. Savings and deposits | [] | d. Input supply/Purchasing service | [] |
| e. Marketing service | [] | f. Agricultural extension services | [] |
| g. Food processing service | [] | h. Farm insurance | |
| i. Other(s), please specify: _____ | | | |
38. How does an AC assist you to increase your household members' education and health? (You may tick more than one)
- | | |
|---------------------------------------------------------------------------------|-----|
| a. AC provides funds for education expenditure | [] |
| b. AC provides funds for medicine expenditure | [] |
| c. AC provides credit related to education | [] |
| d. AC provides credit related to health | [] |
| e. AC provides the facilities on education for members (e.g., training centers) | [] |
| f. AC provides the facilities on health care for members (e.g., health centers) | [] |
| g. Other(s), please specify: _____ | [] |
39. Did you borrow loans from any ACs in the year 2015?
- | | | | |
|---------------------------|-----|--------------------------|-----|
| a. Yes (please go to Q41) | [] | b. No (please go to Q40) | [] |
|---------------------------|-----|--------------------------|-----|
40. If No in Q39, why didn't you borrow loans from ACs? (You may tick more than one)
- | | |
|--------------------------------------------------------------------------------|-----|
| a. Have enough savings/earnings from other sources | [] |
| b. Lack of information | [] |
| c. Do not qualify for AC requirement | [] |
| d. Afraid of having a debt | [] |
| e. Too many required documents to submit | [] |
| f. Lack of collateral | [] |
| g. Interest rates were not affordable | [] |
| h. Uncertainty in repaying the financing/ Lack of ability to pay back the loan | [] |
| i. Incurred previous financing(s) or bad financing record | [] |

- j. Credit application process takes too much time []
- k. Other(s), please specify _____

Next go to Q49

41. If Yes in Q39, what was the purpose of your loans? (*You may tick more than one*)
- Agricultural activities
- a. Expenditure for farm inputs (e.g. seeds, fertilizers, pesticides) []
- b. Farm investment (e.g. preparing land and water source) []
- c. Purchase of farm assets (e.g. farm machine, land) []
- d. Expenditure for operation or running business (e.g., employees and utilities) []
- e. Expenditure for sale and product processing (e.g., information cost, transportation cost, and cost for food processing) []
- f. Livestock raising []
- g. Other(s), please specify: _____
- Non-agricultural activities
- a. Small investment/trade []
- b. Pay for children's education []
- c. Purchasing durable assets (e.g. TV, car) []
- d. Housing (e.g. repair, construction) []
- e. Emergency (e.g. medical, hospitalisation) []
- f. Paying off other debts []
- g. Consumption []
- h. Other(s), please specify: _____
42. What was the total loan amount borrowed from the AC in 2015? (*please specify*): _____ baht
43. What was the duration of your AC loans in 2015? (*please specify*): _____ months
44. What was the loan interest rate charged by the AC in 2015? (*please specify*): _____ percent/year
45. Does your loan(s) require collateral(s)?
- a. Yes (*please go to Q46*) [] b. No (*please go to Q47*) []
46. If Yes in Q45, what kind of collateral(s) was required? (*You may tick more than one*)
- a. Mortgage property (e.g. house, land) []
- b. Chattels mortgage (e.g. vehicles, farm equipment) []
- c. Promissory note []
- d. Co-signer/co-guarantor []
- e. Deposits []
- f. Other(s), please specify: _____
47. Did you borrow from other financial institution(s) in 2015?
- a. Yes (*please go to Q48*) [] b. No (*please go to Q49*) []
48. What was the amount of additional loan borrowed from other sources in 2015? (*please specify*): _____ baht
49. Did you buy farm inputs, particularly seeds, sapling, fertilizers, agro chemical and pesticides from an AC in year 2016?
- a. Yes (*please go to Q51*) [] b. No (*please go to Q50*) []
50. If No in Q49, what are your reasons for not buying farm materials from an AC? (*You may tick more than one*)
- a. Inadequate supply [] b. High price []

- c. Late delivery [] d. Absence of buying on credit []
 e. Inappropriate time for instalment [] f. Poor material quality []
 g. Did not meet my need [] h. Other(s), please specify: _____

Next go to Q55

51. If Yes in Q49, what farm inputs did you buy via an AC in year 2016? (*You may fill more than one*)

Farm inputs	Quantity (kg.)	Cost (baht)
a. Seeds and Sapling	[]	[]
b. Fertilizers	[]	[]
c. Pesticides or agro chemical	[]	[]
d. Fuel for farm machines	[]	[]
e. Farm materials	[]	[]
f. Others (please specify): _____	[]	[]

52. How did you pay for the farm inputs purchased via ACs?
 a. By cash [] b. On credit [] c. Part of cash and part of credit []
53. Did you buy farm inputs from other suppliers in 2016?
 a. Yes (*please go to Q54*) [] b. No (*please go to Q55*) []
54. Which suppliers did you buy farm inputs from? (*You may tick more than one*)
 a. Dealers (retailer or wholesaler) [] b. Private company []
 c. State agency [] d. Other(s), please specify: _____
55. Did you sell your farm products via an AC in year 2016?
 a. Yes (*please go to Q57*) [] b. No (*please go to Q56*) []
56. If No in Q55, what are your reasons for not selling products via an AC? (*You may tick more than one*)
 a. AC does not provide marketing service []
 b. AC does not provide an accurate measurement []
 c. AC does not provide a fair price []
 d. AC requires high quality products []
 e. AC does not deliver your farm products to markets []
 f. AC limits number of time for a trade []
 g. Other(s), please specify: _____

Next go to Q62

57. If yes in Q55, how many kilograms of farm products did you sell via an AC in 2016? (*please specify*): _____ kg
58. What was price received from selling products via an AC in 2016? (*please specify*): _____ baht/kg
59. Have you received delayed payment in selling your farm products via an AC?
 a. Yes [] b. No []
60. In 2016, did you sell your farm products via other marketing channels?
 a. Yes (*please go to Q61*) [] b. No (*please go to Q62*) []
61. Which other marketing channels did you sell your farm products in 2016? (*You may tick more than one*)
 a. Individual selling [] b. Dealer (retailer or wholesaler) []
 c. Supermarket [] d. Exporter []
 e. Agriculture industry [] f. State agency []

g. Agricultural future exchange [] h. Other(s), please specify: _____

62. Did you participate in agricultural extension service provided by an AC in year 2016?

a. Yes (*please proceed to section 3*) [] b. No (*please go to Q63*) []

63. If No in Q62, what are your reasons for not joining agricultural extension services provided by AC? (*You may tick more than one*)

- a. Lack of information (e.g. place, time) [] b. Lack of continuous support []
 c. Lack of facilities [] d. Lack of specialists []
 e. Inconvenience time [] f. Knowledge is difficult to implement []
 g. Inconvenience place (far from my place) [] h. Methodology of teaching is not effective []
 i. Content of extension services did not meet my need [] j. Other(s), please specify: _____

Next please proceed to Section 3

Section 3. General farm information
(for All Respondents)

64. What is/are major crop(s) that you grow? (*you may tick more than one*)

- a. Paddy [] b. Rubber []
 c. Sugarcane [] d. Cassava []
 e. Maize/Corn [] f. Soybean []
 g. Fruits [] h. Vegetables []
 i. Flowers [] j. Oilseeds []
 k. Other(s), please specify: _____

65. How long have you been farming? (total working period includes this year) (*please specify*): _____ years

66. The number of household members participating in farm activities is: persons

67. Do you or your household members participate in off-farm work?

a. Yes [] b. No []

68. The area of your cultivated land in year 2016 is (*please specify*): _____ hectares

69. What is the status of your farmland ownership? (*you may tick more than one*)

- a. Owned my land [] b. Rental land []
 c. Lease land [] d. Other(s), please specify: _____

70. The area of cultivated land in year 2014 was (*please specify*): _____ hectares

71. In 2016, what is the cost of your farm production including farm materials and equipment, soil maintenance, land rent, wage for non-family labour, and transportation? (*please specify*): _____ baht

72. What were the amount of farm inputs you use for the years 2014 and 2016? (*please estimate*):

		2014	2016
Seeds	Quantity used (kg.)		
	Expenditure (baht/ year)		
Fertilizers	Quantity use (kg.)		
	Expenditure (baht/ year)		
Pesticides/ Agro chemical	Quantity use (kg.)		
	Expenditure (baht/ year)		
Others (please specify): _____	Quantity use (kg.)		
	Expenditure (baht/ year)		

Remark: if the unit of fertilizers is in a bag, please ask how much a bag weighs _____ kg.

73. What were your farm output and sale for the years 2014 and 2016? (please estimate):

Year	2014	2016
Yields (kg)		
Sale (kg)		
Product price (baht/kg)		
Margin price (baht/kg)		

Note: Margin price is product price minus cost of production (baht/kg)

74. How far is your farm to the nearest market or township? (please specify): _____ km.

75. Did you need to borrow money in year 2015?

a. Yes (please go to Q76) [] b. No (please go to Q80) []

76. Were you able to get the financing in year 2015?

a. Yes (please go to Q77) [] b. No (please go to Q80) []

77. If Yes in Q76, what was the total loan amount you were able to borrow in 2015? (please specify): _____ baht

78. Which source(s) of financing did you obtain your loan? (You may tick more than one)

1. Formal sources

2. Informal sources

- | | | | |
|-----------------------------------------------------------------------------------|-----|------------------------------------|-----|
| a. Bank for Agriculture and agricultural Cooperatives (BAAC) | [] | a. Private money lender | [] |
| b. Commercial banks (e.g. Krung Thai Bank, Siam Commercial Bank) | [] | b. Middlemen | [] |
| c. Village funds | [] | c. Input supplier | [] |
| d. Agricultural cooperatives (ACs) | [] | d. Friends/neighbours | [] |
| e. Farmer's groups or saving groups | [] | e. Relatives | [] |
| f. Other government agencies (e.g., Revolving loan fund for farmers and the poor) | [] | f. Other(s), please specify: _____ | |
| g. Other(s), please specify: _____ | | | |

79. How far is it from your residence to the nearest credit source? (please specify): _____ km.

80. Have you participated in agricultural extension services provided by any agents in 2016?

a. Yes (please go to Q81) [] b. No (please go to Q82) []

81. How many time did you participate in agricultural extension services last year? (please specify): _____ times

The following questions ask you to compare changes of your household welfare on education and health for the years 2014 and 2016. If you think that in 2016, your household welfare has been significantly improved then it means "Extremely increased", if you think that your household welfare slightly increased then it means "Moderately increased", otherwise "Unchanged".

	No changed	Moderately increased	Extremely increased
82. Adoption of new technologies and modern farm material in farming			
83. Level of farm knowledge (e.g., farm production and management)			
84. Accessibility to hospitals or health centres			

Section 4. Socioeconomic and production characteristics
(for All Respondents)

- 287

95. How much was your annual household income? (please specify the estimated income)

Income (baht/year)	2014	2016
1. Total household income		
2. Net farm income including both cash and noncash		
3. Non-farm income		
4. other incomes		

96. How much was your annual household expenditure? (please specify the estimated expenditure)

Consumption (baht/year)	2014	2016
1. Food expenditure (e.g. food, drink)		
2. Non-food expenditure		
a. Health care expenditure		
b. Education expenditure		
c. Household appliance expenditure		
d. Others non-food expenditure		

*Your participation in this survey is greatly appreciated. Thank you for your time and if you have further comments about credit card, please feel free to comment in the space provided below. Once again, we assure you that your identity will remain **STRICTLY CONFIDENTIAL**.*