

**PRODUCTION EFFICIENCY, RISK PERCEPTIONS AND CHOICES OF
GOVERNANCE STRUCTURE ALONG COFFEE SUPPLY CHAIN IN
SOUTH-WESTERN ETHIOPIA**

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along Coffee Supply Chain in South-Western Ethiopia**

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DOCTOR OF PHILOSOPHY IN AGRICULTURAL ECONOMICS**

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DEDICATION

I dedicate this piece of work to my father, Ato Alemu Senbeta, and my mother, W/o Tiru Kongay, for their unwavering inspiration and encouragement to my success starting from childhood. May God give them a long life.

STATEMENT OF THE AUTHOR

By my signature below, I declare and affirm that this dissertation is my own work. I have followed all ethical and technical principles of scholarship in the preparation, data collection, data analysis and compilation of this dissertation. Any scholarly matter that is included in the dissertation has been given recognition through citation.

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ACRONYMS AND ABBREVIATIONS

AE	Allocative Efficiency
CQCMP	Coffee Quality Control and Marketing Proclamation
CSA	Central Statistics Agency of Ethiopia
CV	Coefficient of Variation
DA	Development Agent
DEA	Data Envelopment Analysis
DPPA	Disaster Prevention and Preparedness Agency
ECEA	Ethiopian Coffee Export Association
ECX	Ethiopian Commodity Exchange
FAO	Food and Agriculture Organization of the United Nations
FGD	Focus Group Discussion
GAIN	Global Agricultural Information Network
GS	Governance Structure
GSC	Governance Structure Choice
GTP	Growth and Transformation Plan
HH	Household
ICO	International Coffee Organization
ICTs	Information Communication Technologies
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
JARC	Jimma Agricultural Research Center
KII	Key Informant Interview
LRS	Likelihood Ratio Statistics
ML	Maximum Likelihood
MoARD	Ministry of Agriculture and Rural Development
MoE	Ministry of Education

ACRONYMS AND ABBREVIATIONS (CONTINUED)

MoFED	Ministry of Finance and Economic Development
MoT	Ministry of Trade
MVP	Multivariate Probit Model
NGOs	Non Governmental Organizations
NIE	New Institutional Economics
OECD	Organization for Economic Cooperation and Development
OLS	Ordinary Least Squares
PCA	Principal Components Analysis
R&D	Research and Development
RMSs	Risk Management Strategies
SFA	Stochastic Frontier Analysis
SNNPR	Southern Nations Nationalities and Peoples Region
TCCCB	Tropical Commodity Coalition Coffee Barometer
TCE	Transaction Cost Economics
TCT	Transaction Cost Theory
TE	Technical Efficiency
TI	Technical Inefficiency
TLU	Total Livestock Unit
TPM	Trivariate Probit Model
USA	United States of America
USDA	United States Department of Agriculture
VIF	Variance Inflation Factor

BIOGRAPHICAL SKETCH

Mebratu Alemu was born on March 24, 1983, in Bullen Woreda, Metekel zone of Benishangul Gumuz region. He attended his primary, secondary and high school education at Bullen primary, junior and senior secondary school, respectively. He received the Bachelor of Arts (BA) degree in Management from Jimma University in 2005 and a Master of Arts degree in Regional and Local Development Studies (RLDS) from Addis Ababa University in 2008.

After his graduation with BA degree in Management, he was employed at Arba Minch University as a graduate assistant I on August 26, 2005. Then he served as a Graduate Assistant I and II until he left for his MA degree study to Addis Ababa University in 2007. After earning his Masters degree, he served as a lecturer of Management and as the Dean of College of Business and Economics from February 2009/10 up until the time he joined Haramaya University to pursue his PhD degree study in 2010/11.

While pursuing his PhD degree, Mr. Mebratu has attended international trainings, conferences and has obtained certificates. To mention a few, he participated at Future Resources Management Workshop in Nairobi, Kenya from 5th to 10th of November 2012. He attended an international training program and received certificate in “Market Access for Sustainable Development; Towards Pro-poor and Smallholder Inclusive Market Development”. Also he had participated in an international seminar held on “Public Private Partnership” from 5-22 November, 2013 at CDI, Wageningen, The Netherlands. He had also an opportunity to take part in the Summer School course on “Food Security and the Post – 2015 Agenda” from March 2-March 13, 2015 including the attendance of the 2nd international Congress on “Hidden Hunger, Childhood Development and Long Term Prospects for Society and Economy” from March 3-March 6, 2015 at the University of Hohenheim, Stuttgart, Germany.

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ABSTRACT

In Ethiopia, growing coffee is considered as the main economic activity for over 15 million people. However, it is inefficient and growers are not in a position to respond to sources of major agricultural risks. Moreover, inadequate coordination of the sector are also highly threatening coffee production and marketing in the study area. The purpose of this study is, therefore, to measure technical efficiency, identify its determinants, identify sources of perceived risks, and choices of governance structure. The data for this study were obtained from a sample of 337 households in Kefa zone of south-western Ethiopia, selected using multistage stratified random sampling technique. Descriptive statistics, Tobit, Multivariate ordered probit, Multivariate probit, and Trivariate Probit models were used to analyze the data. The study revealed that technical efficiency of households ranges from 15 to 94 percent, with a mean of 64 percent, suggesting a considerable inefficiency levels among the studied households. Among the important factors identified, level of education, credit utilization, membership in cooperatives, practice of pruning, use of improved variety, and mobile ownership have negatively and significantly influenced technical inefficiency. The variables such as number of coffee plots, age of coffee tree, and intercropping have positively and significantly determined technical inefficiency. The study further revealed that households perceived production and market risks as the 1st and the 2nd most important sources of risk affecting their coffee farm business. Moreover, financial, institutional, and human related risks have been perceived as the 3rd, 4th, and 5th important sources of risk. Results show that crop and livestock based diversification and pest and disease management as the 1st and 2nd most preferred risk management strategies. In the same vein, households identified non-farm employment, market contracts, and information retrieval and use, as the 3rd, 4th, and 5th relevant risk management strategies, respectively. The Trivariate Probit model result indicated human asset specificity, trust, experience, coffee area to total land ratio, perceived coffee quality, and technical efficiency scores have been found negatively and significantly influencing primary market governance structure choice. Conversely, educational level and physical location appeared to positively and significantly affect primary market type of governance structure. The same model result shows that human asset specificity, connectedness of transactions, uncertainty, and trust are factors influencing households' choice of bilateral contract type of governance structure positively and significantly. Nevertheless, technical efficiency score has been found to negatively and significantly affect households' choice of bilateral contract type of governance structure. Similarly, the model result revealed that uncertainty, trust, connectedness of transactions, household size, perceived quality of coffee, and technical efficiency scores are significant factors that affect households' choice of cooperative type governance structure positively. This study suggests the significance of education, cooperatives, credit utilization, mobile ownership, use of improved coffee variety, and pruning for improving households' level of technical efficiency. Technically efficient smallholder coffee growers do less likely participate in spot market and bilateral contract based type of transactions, but more likely participate in cooperative type of governance structure. Thus, analysis of governance structure choice can be used as powerful tool in defining intervention strategies in promoting transactions in cooperative type of governance structure.

Keywords: Technical efficiency, Risk perceptions, Risk management strategies, Governance structure choice, Smallholder coffee growers, South-western Ethiopia.

1. INTRODUCTION

1.1. Background

As one of the world's most traded commodities, coffee and its cultivation play a decisive role in the livelihoods of approximately 25 million smallholder farmers. These farmers produce 80 percent of the world's coffee production. The world coffee production for the year 2015/16 has been 147.9 million bags¹, of which 85.81 million constitute an Arabica coffee (ICO, 2016). When compared with the year 2013/14, there is a 2.5 percent estimated reduction in global production of Arabica coffee in 2015/16.

Despite the fact that coffee is grown in more than 70 countries, over 73 per cent of the world's coffee is produced only by just five of them – Brazil, Vietnam, Colombia, Indonesia, and Ethiopia. Brazil has long been by far the world's largest coffee producer, growing about 48.42 million bags in the year 2015/16. Vietnam is next (27.5 million bags) followed by Colombia (14 million bags), Indonesia (11.5 million bags), and Ethiopia (6.7 million bags). Moreover, world coffee production has remained below demand due to under-investment, poor production practices, adverse climatic conditions, lack of interest from the next generation of coffee growers, and ageing coffee trees (Lucia, 2012).

The global coffee consumption continues to grow at a steady pace, particularly in the emerging markets such as those in Eastern Europe and Asia, and in the coffee producing countries themselves. ICO (2016) estimate shows the world coffee consumption in 2015/16 is about 151.3 million bags, and the world coffee consumption increased at an average rate of 1.3 percent per annum (ICO, 2016). Looking at the same report, coffee producing countries consume 30.6 per cent of the world's coffee, led by Brazil whose consumption reached 20.5 million bags followed by Philippines (4.1 million bags) and Ethiopia (3.6 million bags) in the year 2015/16. The remaining 69.4 per cent of coffee produced is traded internationally; the US is the biggest importer, importing 24.5 million bags in the year 2015/16, followed by Japan (7.7 million bags) and Russia (3.9 million bags). African countries account for 11.4 (16.8 million bags) and 7.1 (10.8 million bags) percents of

¹ One bag weighs 60 kg of coffee.

global coffee production and consumption, respectively.

As the birthplace of coffee Arabica, Ethiopia is still a major producing country of high-value coffee. In Ethiopia, coffee is produced under four major production systems, *i.e.* forest coffee (8-10 percent), semi-forest coffee (30-35 percent), cottage or garden coffee (50-57 percent) and modern coffee plantations (5 percent). It has accounted, on average, for about 5 percent of gross domestic product (GDP), and 10 percent of total agricultural production in 2011. The country produced around 5 percent of world production and 39 percent of the total production of coffee in Sub-Saharan Africa (MoT, 2012).

According to MoT (2012) Coffee is considered the main export crop in the country, providing 31 percent of Ethiopia's foreign exchange earnings. Over 4 million small-scale farmers produce 95 percent of the total coffee output, and 25 percent of the Ethiopian population directly or indirectly depend on the coffee value chain for their income and employment (Arslan and Reicher, 2011; CSA, 2013). Ethiopia is also a coffee consuming country, with more than 55 percent of coffee produced in Ethiopia is locally consumed in 2015/16, reflecting the commodity's cultural and social importance in the country (ICO, 2016). In 2014/15, Ethiopia exported 2.8 million bags, making it the most important African coffee exporter and the tenth largest exporter in the world (ICO, 2016). Its share of the international coffee trade in the same year was about 3 percent.

Despite all the economic and social importance of coffee, unfortunately, smallholder coffee producers² in south-western part of Ethiopia are often unable to take advantage of this business opportunity due to lack of "know how" to choose the right actor to make transactions with. Moreover, degraded soils, prevalence of different sources of risks, inadequate access to inputs, poor coffee management practices, prevalence of few coffee suppliers are added barriers that put sustainable livelihoods out of the reach of many smallholder coffee growers in south-western Ethiopia (Zekarias *et al.*, 2012).

In order to overcome these challenges, attempts have been made through expansion of the use of modern inputs like chemical fertilizers, improved seed, herbicides/pesticides and new agronomic practices. Although high yields can be obtained in good soil and favorable weather conditions, the

² In this dissertation, smallholder coffee producer refers to small-scale coffee producing households who are involved in the production of coffee for sale or consumption.

overall national average yield of coffee for the year 2014/15 is 748 kg/ha (CSA, 2015). A combination of many factors including weakly functioning agricultural markets, low purchasing power of the local consumers, overall low level of technical knowledge of producers, a high illiteracy rate of the rural communities, inefficient use of natural resources, increasing demand for high quality coffee, low profitability of the coffee farmers, and lack of competitiveness in the coffee sector have hindered the much expected technical change and farm productivity (Taye *et al.*, 2011).

According to Boansi and Crentsil (2013) the trend in yields of coffee in Ethiopia has been generally positive, but there still exists room for further improvement as the national average yield (730 kg/ha) lags well behind yields in other major exporting countries like Vietnam (2200 kg/ha), Costa Rica (1010 kg/ha), Brazil (1300 kg/ha), Guatemala (970 kg/ha), and Honduras (1070 kg/ha). Furthermore, it is below the world average yield for green coffee (790 kg/ha). It is, however, well above the average for Africa (470 kg/ha), Kenya (240 kg/ha), Indonesia (490 kg/ha) and Colombia (630 kg/ha). This indicates the existence of a room for further improving the productivity of smallholder coffee growers in Ethiopia.

Production inefficiency primarily harms the income of coffee farmers and other actors along the coffee supply chain and discourages the production of coffee; and secondly it also significantly decreases the country's foreign exchange earnings (which is an important asset the country extremely needs) obtained from coffee production and trading. This suggests that it is very crucial to study and identify factors contributing to the technical inefficiency of smallholder coffee growers with a view to improve their technical efficiency.

Experiences across multiple commodities and countries have verified that an inability to adequately manage sources of agricultural risks in an *ex-ante* manner, have at times rendered agricultural supply chains uncompetitive, resulting in economic hardship for rural populations (World Bank, 2012). Similarly, inability of smallholder farmers to adequately manage risks is often one of the primary reasons for financial institutions for being unwilling to provide sufficient loan to agricultural actors, the other being lack of security for such loans. It is often taken for granted that these effects are mutually reinforcing with unmanaged risks resulting in an ever greater reluctance of lenders to lend; and lack of financing lead to reduced opportunities of stakeholders for implementing risk management measures.

Smallholder coffee farming, which has been an important pillar of the Ethiopian economy for centuries, has been confronted with various problems both internal such as weather and biological related risks, weak markets, insufficient infrastructure, insufficient research and extension, shortage of farmland (Taye, 2010) and external (*e.g.* global coffee price decline, increasing food and oil prices), which threaten expansion of a dynamic and commercially oriented smallholder coffee sub-sector. Likewise, very little evidence has been documented about how improved risk management in the coffee sector might result in the betterment of smallholder coffee growers' performance along the coffee supply chain in south-western coffee growing areas of Ethiopia.

Thus, risk becomes a central issue in the rural areas that affects many different aspects of people's livelihoods in Sub-Saharan Africa and Ethiopia, in particular. Perceptions about major risk sources and preferences about risk management strategies play a key role in the production and marketing decisions of smallholder coffee growers. But, only limited attention has been paid to understand its nature and distribution in cash-crop farming like coffee. Moreover, unless well managed, risks in coffee farming can slow development and hinder poverty reduction. To have an insightful understanding about household's farm decision, analysis of the factors affecting households' perception about major sources of risks (production, market, financial, institutional and human related) and their responses about the importance of risk management strategies is deemed noteworthy.

Within the existing portfolio of governance structural choices in the coffee supply chain ranging from spot market to collective actions, smallholder coffee farmers are making several governance structural choices for transacting coffee in different markets. Bearing in mind the lack of scientific evidence on factors affecting governance structural choices of smallholder coffee growers in Ethiopia and to deepen the understanding of how and why smallholder coffee growers select governance structures, it becomes essential to investigate the different governance choices that smallholder coffee growers choose to supply their produce to different buyers in the study areas.

1.2. Statement of the Problem

In Ethiopia, coffee is the most popular and widespread cash crop in several parts of the regional states. It provides cash income throughout the year and its transportability favors even the outlying communities. However, coffee production is inefficient and not as remunerative as it could be

(Zekarias *et al.*, 2012). Despite the fact that Ethiopia has a comparative advantage in export of coffee, the overall performance on the international market is weak owing to factors such as challenges with management of price risk, high transaction costs resulting from the extensive nature of the supply chain, and the numerous actors and processes therein (Boansi and Crentsil, 2013).

The south-western highlands of Ethiopia are considered the birth place to Arabica coffee (*Coffea arabica* L.) and home to the enormous wealth of genetic diversity. However, the average national coffee yield remains low (Taye *et al.*, 2011). A major challenge confronting coffee farmers is on how much to increase production efficiency among smallholder coffee growers, both to meet growing demand for consumption and to offset yield losses due to production inefficiency. Moreover, production is characterized by limited use of fertilizers and pesticides with manual cultivation and drying processes (GAIN, 2012). According to the same report, production per hectare is low, with limited specialized government institution providing extension support for coffee production.

Smallholder coffee growers in south-western coffee growing areas of Ethiopia face various risks at production, processing, and marketing. The risks most commonly referred to include the high incidence of Coffee Berry Disease (CBD), with great impact making the production potential at risk; shortage of improved cultivars adapted to different localities; poor harvest and post-harvest practices reducing coffee quality; and weak linkages between research, extension services and producers (Taye, 2008). Moreover, challenges with quality control, incidence of smuggling and high transaction costs, and/or inadequate coordination between firms are highly threatening coffee transaction arrangements and the national GDP.

For smallholders to make profit from selling in local, regional and export markets, they have established bi- or multilateral forms of governance structures. Within the existing portfolio of governance structures in the coffee supply chain ranging from spot/primary market to cooperatives or unions, smallholder farmers are simultaneously making several choices for transacting coffee – characterized by various quality levels sold in different markets. In fact, limited study has been undertaken to evaluate and identify factors affecting governance structure choices of smallholder coffee farmers in the perspective of transaction cost economic theory.

Smallholder coffee producers face many risks which arise from natural, economic and socio-

political environments. A great deal has been written about some of the problems faced by the coffee sector, especially, during the period known as the “Coffee Crisis” when coffee prices dropped to low levels and remained there for a number of years (World Bank, 2005). However, to date coffee sector risks, across a variety of producing countries, and particularly in Ethiopia have not been considered in a comprehensive manner. In spite of the pivotal role played by coffee, particularly in the economies of millions of smallholder coffee growers in Ethiopia, both production and prices of coffee have been showing variability reflecting the presence of production and marketing risks.

Risk sharing institutions like national insurance and credit schemes that help reduce the burden of risk to society are weak in south western coffee growing areas. Private sector insurance products are still in their development stages and this has prompted farmers to turn to self-insurance strategies that include diversification and social mechanisms for dealing with risk. Moreover, smallholder coffee producers are not in a position to respond to the demands since their production system is largely seasonal, and they are not well aware of the emerging market situation. Within this context, there is a need to understand the determinants of risk perceptions and risk management strategies of smallholder coffee growers’ along the coffee supply chain in the study area.

Many studies have been carried out with the view to informing future policy prescriptions, but majority of them have focused on issues related to coffee export and marketing performance (Zekarias *et al.*, 2012; Boansi and Crentsil, 2013), price transmission (Worako *et al.*, 2008), commercialization of agriculture in coffee growing areas (Gebreselassie and Ludie, 2008) and marketing and trading policies (ICO, 2010). However, in-depth literature on Ethiopia’s coffee sector is scarce, if not non-existent, except for a few consultancy reports for donor-funded projects.

Enhancing the lion’s share of foreign currency from coffee in Ethiopia, can be attained by improving the productive efficiency of coffee growers, that is, their ability to derive the greatest amount of output possible from a fixed quantity of inputs. In fact, the presence of shortfalls in efficiency means that output can be increased without requiring additional conventional inputs or new technologies. If this is the case, then empirical study on coffee growers’ production efficiency and its determinants and identifying their risk perceptions, management strategies and choices of governance structure are vital in order to determine the magnitude of the gain that could be obtained

with a given technology, inputs, institutional and marketing arrangements.

Given the impetus of the coffee sector to the Ethiopian economy and all the efforts the government has put in place to reform the sector, there exists a strong case to assess production efficiency, risk perceptions, risk management strategies and governance structure choices of smallholder coffee growers in south-western Ethiopia, known with organic coffee production in the country. To this end, this study strives to bridge the existing knowledge gap on identifying the determinants of technical inefficiency of coffee production, perceived sources of coffee farm risks, risk management strategies and choices of governance structure in the study area.

1.3. Research Questions

The present study attempts to address the following key research questions:

- What is the level of technical efficiency of smallholder coffee growers?
- What are the sources of technical efficiency differentials among smallholder coffee growers in the study area?
- What are the perceived sources of risks by smallholder coffee growers? Are these risks differentiated?
- What are the determining factors of risk perceptions and risk responses of smallholder coffee growers?
- What are the intrinsic and extrinsic factors affecting the governance structure choices of smallholder coffee farmers in the coffee transactions?

1.4. Objectives of the Study

The main objective of the study is to assess farm productivity, risk perceptions and governance structure choices of smallholder coffee growers in south-western Ethiopia.

The specific objectives of the study are:

1. To measure the technical efficiency of smallholder coffee growers;
2. To identify the determinants of technical inefficiency differentials of smallholder coffee growers;
3. To identify sources of perceived risk, and determinants of risk perceptions among smallholder coffee growers

4. To identify factors determining risk management strategies of smallholder coffee growers;
5. To identify factors affecting governance structural choices in coffee transactions.

1.5. Significance of the Study

This study has both conceptual and practical importance. At the practical level, analyzing and identifying sources of perceived risk, determinants and risk management strategies of smallholder coffee farmers are crucial to improve smallholder coffee farmers' technical efficiencies by revising the risk management policy interventions in the coffee sector in particular, and the agricultural sector of the country, in general.

In addition, measuring technical efficiency of smallholder coffee farmers and identifying factors affecting them may provide useful information for the formulation of economic policies that are likely to improve technical efficiency of smallholder farmers involved in coffee production. It is anticipated that using information derived from such studies, farms or plantations may become more efficient, competitive and hence more profitable.

The types and severity of risks that farmers face differ from place to place. Incorporating and understanding smallholder coffee growers' perception about the sources of risk and the management strategies will benefit policy makers who develop appropriate strategies that can help farmers survive the numerous risks they confront. Thus, understanding how smallholder coffee farmers react to risk factors is important not only for the farmers themselves, but also for the extension services, the agri-food industry and government authorities.

The study also contributes to validate a new construct, namely "Governance structure", to deepen the understanding of how and why coffee farmers select governance structures in Ethiopia. In light of transaction cost theory, the study helps in understanding the major reasons guiding the choice of governance structures in coffee transaction, using a broader range of explanatory factors. This study also provides empirical evidence in the transaction cost theory and the choice of governance structure, among smallholder coffee farmers in south western coffee growing areas of Ethiopia. Moreover, this study puts forth empirical evidence on the relationship between technical efficiency scores with governance structure choices and with households' perception towards the sources of

major agricultural risks in the study area. The results of this study do fill this gap. The output of this study could also serve as a reference material for academicians, government bodies, researchers and to all who are interested to pursue further investigation on similar and related topics.

1.6. Scope and Limitations of the Study

This study is a microeconomic analysis based on data collected using cross-sectional survey of coffee growers, and traders in Kefa zone of SNNPR. Actually the findings are pertinent mainly to the study areas; but also may be extended to other areas with similar socio-economic and agro-ecological characteristics. More importantly, further studies require large and rich dataset, such as time series or panel dataset, and more coffee growing sample woredas from other Zones will not be covered in the present study due to time and budget constraints. Moreover, since coffee is a perennial crop where harvesting takes place 4 or 5 years after the tree is planted, it has been difficult to get cost data until the harvest time and hence allocative and economic efficiencies were not carried out.

Recent empirical literature pertinent to coffee are few, particularly on risk perception and governance structure choices among smallholder coffee growers. Thus, it has not been very easy to make comparative analysis and support the results of the findings with recently published works related to the study.

1.7. Organization of the Dissertation

The remaining part of this dissertation is organized as follows. Chapter 2 summarizes and presents literature pertinent to the study. The first section of the chapter deals with available theoretical aspects. It traces the technical efficiency theory, the measurement and specification issues of a production function. This section also addresses the different theories of risk, and risk perception and transaction cost economics theories. Chapter 2 also presents the conceptual framework and the empirical literature on technical efficiency, risk perceptions and governance structure choices.

Chapter 3 addresses methodological orientations. This includes the description of the study area, sampling design, sampling procedures, sample size, data collection methods and types of data, and

data analysis techniques. This chapter also explains the econometric model specifications that are used in this dissertation. Chapter 4 addresses the results and discussion part of the dissertation. Finally, chapter 5 summarizes the findings of the study, discusses the implications of the findings, and provides signposts as to how the smallholder coffee farmers enhance their technical efficiency; manage different risks they perceive and choice of governance structures, in the study areas, in particular.

2. REVIEW OF LITERATURE

This chapter reviews the basic concepts, the available theoretical, conceptual and empirical literature on production efficiencies, governance structures, risk perceptions and risk management strategies among smallholder coffee growers. The chapter includes sections and sub-sections that deal with basic theoretical perspectives, conceptual and methodological frameworks and a wide range of empirical literature pertinent to the present study. In addition, this chapter intends to critically review past research works that are relevant to the present study objectives to have better understanding of the subject.

2.1. Operational Definitions and Concepts

2.1.1. Technical efficiency

Technical efficiency of a farm is the ratio of farm's actual output to the technically maximum possible output, at given level of resources (Battese and Coelli, 1995; Adediji *et al.*, 2013). Technical efficiency can be defined as the ability and willingness of a production unit to obtain the maximum possible output with a specified endowment of inputs (represented by a frontier production function), given the surrounding technology and environmental conditions. Thus, a producer is technically efficient when s/he maximize output for given set of inputs and production technology; this can only be achieved when optimal input mixes and timing is used. A particular method of producing a given level of output is technically efficient if there are no other ways of producing the output that use less of at least one input while not using more of any others.

Coffee supplier: is a person who, upon meeting the required criteria, collects coffee with pulp or red cherry from producers or from his own farm for delivery to auction centers or to the Ethiopian Commodity Exchange.

2.1.2. Risks in agriculture

Risk is uncertainty that affects an individual's welfare, and is often associated with adversity and loss (Bodie and Merton, 1998). Risk is a major concern in developing countries where farmers have imperfect information to forecast things such as farm input prices, product prices, and weather conditions, that might impact the farms in the future (Dunn, 2002).

Sources of risk

There are many sources of risk in agriculture, ranging from price and yield risk to the personal risks associated with injury or poor health. In dealing with risky situations, risk management involves choosing among alternatives to reduce the effects of the various types of risk. Agricultural production implies an expected outcome or yield. Growers have three choices in dealing with agricultural risks. Initially, they can control or minimize risk through management practices by doing a better job of what they currently do. Secondly, they can reduce production variability by making changes such as diversifying, integrating, applying new technology, etc. Finally, they can also transfer risks to someone else through contracting, purchasing insurance, etc.

Some risks are unique to agriculture, such as the risk of bad weather significantly reducing yields within a given year. Other risks, such as the price or institutional risks discussed below, which are common to all businesses, reflect an added economic cost to the producer. If the farmer's benefit-cost tradeoff favors mitigation, then he or she will attempt to lower the possibility of adverse effects. The varied sources of risk in agriculture are reviewed and presented hereunder.

Production or yield risk

This type of risk occurs when agriculture is affected by many uncontrollable events that are often related to weather, including excessive or insufficient rainfall, extreme temperatures, climate changes, hail, insects, pests and diseases (Harwood *et al.*, 1999). Technology plays a key role in production risk in farming. The rapid introduction of new crop varieties and production techniques often offers the potential for improved efficiency, but may at times yield poor results, particularly in the short term. In contrast, the threat of obsolescence exists with certain practices (for example, using machinery for which parts are no longer available), which creates another, and different kind of risk.

In dealing with production risks³ smallholder coffee growers need to control or minimize risk through management practices. This include practicing preventative maintenance such as pest and

³ **Production risks** include bad weather, pests and diseases, fire, soil erosion, other kinds of environmental degradation, and other events that negatively affect the production of agricultural commodities (Hardaker *et al.*, 2004).

disease management, and monitoring production activities more closely to ensure problems are detected early enough to take corrective measures. The second choice smallholder coffee growers should carry out is to reduce production variability. Generally, this means reconfiguring the farming activity by adding or changing enterprises through crop and livestock diversification or integration, and applying improved technology as appropriate. A big part of reducing coffee yield variability is to actively plan for the future and prepare a contingency plan for undesirable events. The third alternative that smallholder coffee growers apply in managing production risk is to transfer some or all of the risk to someone else using contracting (production and marketing) and crop insurance are the two effective tools to transfer risk.

Price or market risk

This type of risk is any market related activity or event that leads to the variability of prices farmers receive for their products or pay for production inputs. In agriculture, production generally is a lengthy process. Because markets are generally complex and involve both domestic and international considerations, producer returns may be dramatically affected by events in far-remote regions of the world.

As one of the most highly perceived sources of agricultural risk, managing marketing risk⁴ need to be given more weight. This is because handling these sources of risks has an effect on farmers' production and legal decisions. For example marketing decisions often involve contractual arrangements which have legal implications. Use of contracting, non-farm employment, and better storage facilities are important to handle marketing risks (Hardaker *et al.*, 2004). Since storage is a way of avoiding seasonally low prices, when prices are below the level anticipated and there is a realistic expectation of a market price increase, then storing coffee beans in a well furnished storage may be justified, assuming that smallholder coffee growers have adequate financial resources to satisfy their basic needs.

4 Market risks include volatile prices of agricultural commodities, inputs (fertilizer, pesticide, seed, and so on), and exchange rates, as well as counterparty risks, theft, risk of failure to comply with quality or sanitary standards, or risks imposed by logistics. These risks usually emanate from market actors (such as traders and exporters), and their effects are transmitted back to the farm (Hardaker *et al.*, 2004).

Institutional or legal risk

This kind of risk results from changes in policies and regulations that affect agriculture. Legal risks to the farm business arise from disputes or disagreements between individuals, between individuals and groups, or between groups. These risks occur when there is an imbalance in power or information between parties. The adverse effects of legal risk result when one party exercises inappropriate action that results in damage to the other party. The aggrieved party has suffered as a result of actions which they were not expecting. That is, they have been affected by the uncertain responses of others. For example, acquiring an operating loan has legal implications if not repaid in the specified manner. Production activities involving the use of pesticides have legal implications if appropriate safety precautions are not taken.

Human issues associated with agriculture also have legal implications, ranging from employer/employee rules and regulations, to inheritance laws. Generally, legal issues most commonly associated with agriculture fall into five broad categories: Contractual arrangements; business organization; laws and regulations; tort liability; and public policy and attitudes. According to Laurence *et al.* (2014) the legal risk arises when a lack of knowledge of laws and regulations leads to noncompliance. Failure to obey the laws and regulations may have serious consequences in terms of fines, criminal penalties, and/ or abatement.

Human or personal risks

People are both a source of business risk and an important part of the strategy for dealing with risk. Disruptive changes may result from such events as death, divorce, injury, or the poor health of a principal in the firm. In addition, the changing objectives of individuals involved in the farming enterprise may have significant effects on the long-run performance of the operation. At its core, human risk management is the ability to keep all people who are involved in the business safe, satisfied and productive (Hardaker *et al.*, 2004).

Financial risks

Financial risk encompasses those risks that threaten the financial health of the business and has four basic components: The cost and availability of capital; ability to meet cash flow needs in a timely

manner; ability to maintain and grow equity and the ability to absorb short-term financial shocks. Financial risk differs from the business risks previously described in that it results from the way the firm's capital is obtained and financed. A farmer may be subject to fluctuations in interest rates on borrowed capital, or face cash flow difficulties if there are insufficient funds to repay creditors. The use of borrowed funds means that a share of the returns from the business must be allocated to meeting debt payments. Even when a farm is 100-percent owner financed, the operator's capital is still exposed to the probability of losing equity or net worth.

According to Laurence *et al.* (2014), to address the major elements of financial risk, a good set of financial records is mandatory. These records provide the flow of information needed to evaluate past performance and plan future strategies through a set of specific financial statements. Financial statements provide the basis to monitor the financial position, control expenditures, and measure various aspects of the financial performance of the business. The essential financial statements are the balance sheet, statement of owner's equity, income statement and cash flow statement.

Risk perceptions

Rohrmann (2008) defines risk perceptions as people's judgments and evaluations of hazards they (or their facilities, or environments) are or might be exposed to. Risk perceptions are interpretations of the world, based on experiences and/or beliefs. They are embedded in the norms, value systems and cultural idiosyncrasies of societies (Finucane and Holup, 2006; French *et al.* 2006). According to Sjoberg (1998), risk perception is all about the thoughts, beliefs, and constructs of human beings. So, risk perception encompasses the mental processing of risk information and coping mechanisms that people use in dealing with uncertain outcomes. Risk perceptions influence an individual's risk-taking behavior, such as business decisions regarding project initiation and continuation (Keil *et al.* 2000). Therefore, both finance scholars and investment professionals are aware that an individual's perception of risk might influence business decisions and investment activity. Thus, smallholder coffee growers' perceptions about sources of major agricultural risks and responses to these risks are important in understanding their risk behaviors'.

It is notable that most people have views about every risk, regardless of whether they are exposed to it or not. Risk perceptions steer decisions about the acceptability of risks and are a core influence

on behaviors before, during and after a disaster. However, neither perceptions of nor attitudes towards risk should be taken as equivalents of actual behavior (Rohrmann, 2008).

The perception of risk and uncertainty is that risk is present when future events occur with measurable probability (Lohano and King, 2009). Every business that is confronted with risky decisions should know the consequences of its decisions, that is, the magnitude of risk accepted, which means that the business must know the probability of how much money can be lost or gained on any given venture.

Risk management strategies in agriculture

For an individual farmer, according to Hardaker *et al.* (2004), risk management involves finding the preferred combination of activities with uncertain outcomes and varying levels of expected return. One might say that risk management involves choosing among alternatives for reducing the effects of risk on a farm, and in so doing, affecting the farmers' welfare position.

Managing agricultural risk is particularly important for smallholder farmers who are usually already vulnerable to poverty and lack the resources to absorb shocks because they lack resources to mitigate, transfer, and cope with risk. Typical shocks such as drought or a pronounced drop in market prices prevent poor households from acquiring assets or making the most of the assets they have (Cole *et al.*, 2008).

Exposure to risk prevents farmers from easily planning ahead and making investments. In turn, risk inhibits external parties' willingness to invest in agriculture because of the uncertainty about the expected returns. Improved management of agricultural risk has significant potential to increase productivity enhancing investments in agriculture (World Bank, 2005).

Agrarian communities have traditionally employed various formal and informal strategies to manage agricultural risk, either before or after the effects of risk are felt. *Ex ante* strategies (adopted before a risky event occurs) can reduce risk (by eradicating pests, for example) or limit exposure to risk (a farmer can grow pest-resistant varieties or diversify into crops unaffected by those pests). Risk can also be mitigated *ex ante* by buying insurance or through other responses to expected losses such as self-insurance (precautionary savings) or reliance on social networks (for access to

community savings, for example).

Ex post strategies (adopted to cope with losses from risks that have already occurred) include selling assets, seeking temporary employment, and migrating. Governments sometime forgive debts or provide formal safety nets such as subsidies, rural public works programs, and food aid to help farms and firms (and their laborers) cope with negative impacts of risky events.

Each strategy for managing risk can be carried out through a variety of instruments, each with different private and public costs and benefits, which might either increase or decrease the vulnerability of individual participants and the supply chain. When selecting a mix of risk responses, it is essential to consider the many links between risk management strategies and instruments (Jaffee *et al.*, 2010).

To sum up, according to World Bank (2005) agricultural risk management strategies can be classified into three broad categories:

Risk mitigation: These actions prevent events from occurring, limit their occurrence, or reduce the severity of the resulting losses. Examples include pest and disease management strategies, crop diversification, and extension advice.

Risk transfer: These actions transfer risk to a willing third party, at a cost. Financial transfer mechanisms trigger compensation or reduce losses generated by a given risk, and they can include insurance, reinsurance, and financial hedging tools.

Risk coping: These actions help the victims of a risky event (a shock such as a drought, flood, or pest epidemic) cope with the losses it causes, and they can include government assistance to farmers, debt restructuring, and remittances. Government and other public institutions, through their social safety net programs, play a big role in helping farmers cope with risk.

2.1.3. Governance structure

According to Williamson (2000), governance structures or institutional arrangements are defined as alternative modes of organization described in terms of their patterns of attributes that differ in discrete structural ways. These structures are ‘designed by trading partners to mediate particular

economic relationships' (Klein, 1999). They are confined within specific 'institutional environments' or the 'rules of the game', that guide individuals' behaviour whether formal (constitutions, laws, property rights) and/or informal social conventions and norms (North, 2005).

Hendrikse (2003) also indicates that a governance structure consists of a collection of rules or institutions and constraints structuring the transactions between the various stakeholders in the value chain. Thus, in NIE literature, governance structure has been defined as the institutional matrix that encapsulates the configuration of multi-stage business arrangements within a given strategic network (Sauvé, 2002).

2.2. Theoretical Framework

This section describes the theories of production efficiency, governance structure choices from transaction cost economics perspective, risk perceptions and risk management strategies.

2.2.1. Theoretical perspectives of technical efficiency

In economic theory, a production function is described in terms of maximum output that can be produced from a specified set of inputs, given the existing technology available to the farm (Battese, 1992). When the farm produces at the best production frontier, it is considered efficient. The most common assumption is that the goal of the producers is profit maximization. However, it is believed that the objectives and goals of the producer are intertwined with farmers' psychological makeup (Debertin, 1992). Therefore, this study assumes that producers aim at maximizing output subject to existing constraints. Technical efficiency is achieved when a high level of output is realized given a similar level of inputs. It is therefore concerned with the efficiency of the input to output transformation. The main function of technical efficiency research is to understand factors that shift production function upwards (Esparon and Sturgess, 1989).

Thus, technical efficiency refers to the ability of producing a given level of output with a minimum quantity of inputs under a given technology. Farrell's (1957) model, which is known as a deterministic nonparametric frontier (Forsund *et al.*, 1980), attributes any deviation from the frontier to inefficiency and imposes no functional form on the data. Several extensions of Farrell's deterministic model have been made by economists such as Aigner and Chu (1968), Richmond (1974) and Greene (1980) among others.

The terms productivity and efficiency, have been used frequently by different authors interchangeably. However, they are not precisely the same. According to Coelli *et al.* (2005), productivity of a firm is termed as the ratio of the output(s) that it produces to the input(s) that it uses. When referred to productivity, it is about total factor productivity, which is a productivity measure involving all factors of production and it also incorporates all outputs. To illustrate the distinctions between the terms, it is useful to consider a simple production process in which a single input (X) is used to produce a single output (Y). As can be seen in Figure 1 below, the line OF' represents a production frontier that may be used to define the relationship between the input and the output. The production frontier represents the maximum output attainable from each input level. Hence it reflects the current state of technology in the industry. If firms in this industry operate on that frontier, then they are technically efficient, or beneath the frontier, if they are not technically efficient. Point A represents an inefficient point whereas points B and C represent efficient points. A firm operating at Point A is inefficient because technically it could increase output to the level associated with the point B without requiring more input.

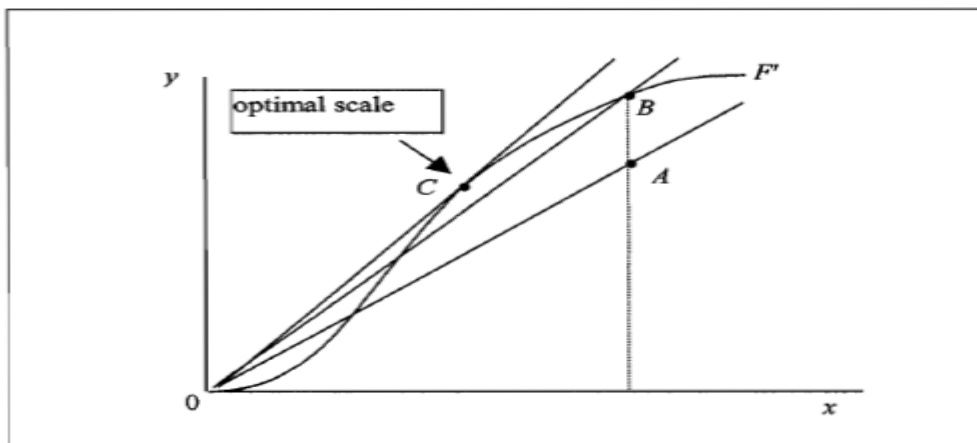


Figure 1: Production frontiers and technical efficiency

Source: Coelli *et al.* (2005)

When firms observe an increase in productivity from one year to the next, the improvement need not have been from efficiency improvements alone, but may have been due to technical change or the exploitation of scale economies or from some combination of the three elements (Coelli *et al.*, 2005). Farrel (1957) proposed that the efficiency of a firm consists of two components: technical efficiency, which reflects the ability of the firm to obtain maximum output from a given set of input,

and allocative efficiency, which reflects the ability of a firm to use the inputs in optimal proportions, given their respective prices and the production technology. These two measures are then combined to provide a measure of total economic efficiency.

Farrel (1957) also illustrated his ideas using a simple example involving firms that use two inputs (x_1 and x_2) to produce a single output (q), under the assumption of constant returns to scale (see Figure 2). Knowledge of the unit isoquant of full efficient firms, represented by SS' in (Figure 2), permits the measurement of TE. If a given firm uses quantities of inputs, defined by the point P , to produce a unit of output, the TE of that firm could be represented by the distance QP , which is the amount by which all inputs could be proportionally reduced without a reduction in output. This is usually expressed in percentage terms by the ratio QP/OP , which represents the percentage by which all inputs need to be reduced to achieve technically efficient production.

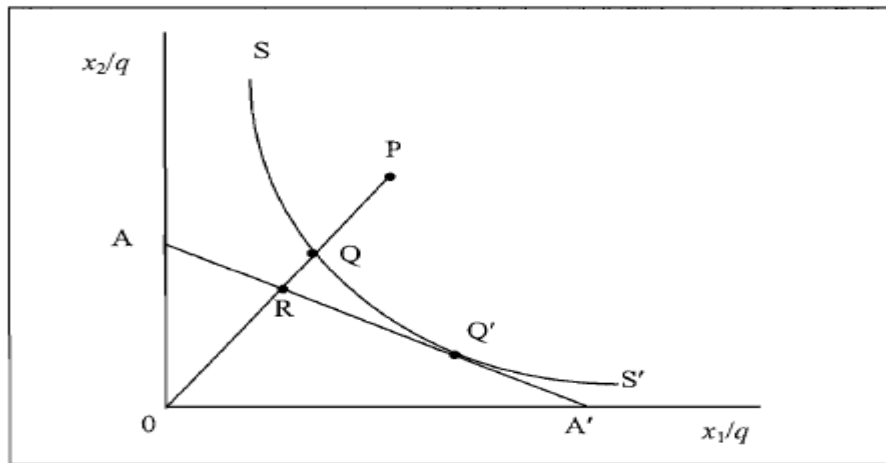


Figure 2: Technical and allocative efficiencies

The technical efficiency of a firm is most commonly measured by the ratio: $TE = \frac{OQ}{OP}$, which is equal to one minus QP/OP . It takes values between zero and one, and hence, provides an indicator of the degree of TE of the Firm. A value of one implies that the firm is fully technically efficient. For example, point Q on Figure 2 above is technically efficient because it lies on the efficient isoquant.

The specification of production technology forms the basis for the conceptualization and measurement of efficiency. The determination of a benchmark for efficiency analysis depends on certain assumptions to be made about the behavior of the firm. The behavior of the production

entity or the firm can be described either by the production function, cost function, profit function or demand and supply functions (Coelli *et al.*, 2005). A rational decision maker will always attempt to maximize the gains and minimize the losses, which are defined by the respective maximization or minimization functions. Yet, there are different alternative economic theories of household behavior, which assume that households maximize one or more household objectives.

The production technology that transforms inputs $X \in R^n$ into net outputs $Y \in R^n$ is modeled by the production function $Y \equiv f(X)$, where $f(X)$ specifies the maximum output obtainable from the input vector X . This function represents the maximum attainable output for a given set of inputs. In other words, it represents a locus of efficient input-output combinations. The production technology is thus, a mathematical relation which transforms inputs into outputs and it gives the set of all technologically feasible input-output vectors. Production economics focuses not only on how resources are allocated but also on developing an efficient method of allocating resources to attain growth or economic development.

Production in general may be increased in different ways. First, production may be increased through increased use of inputs, termed as horizontal expansion. In order for producers to use more inputs, either output prices must increase or input prices must fall or both. This source of economic growth has little applicability in the present economic and social environment in Ethiopia, which is faced with resource limitations. Output can also be increased by improving efficiency usually referred to as the improvement approach. This approach requires the improvement of conditions or the removal of some existing institutional constraints to increase output using the existing technology. The other major source of growth is the transformation approach, which is characterized by a shift or an improvement in farm technology such as the use of technical packages, including improved seeds, fertilizers, credit, and chemicals that shift the production function outwards.

In this study, the combination of both the improvement and the transformational approaches are used to guide the production efficiency analysis. This is because the production efficiency of smallholder coffee growers in the study areas could be improved by improving farm technologies and reducing institutional constraints.

2.2.2. Theoretical perspectives of risk perception and risk management

Smallholder farmers in rural areas of developing countries face risky decisions every day (e.g. technology adoption, weather variability). These decisions have a significant effect on wealth and are a main cause of low yields, slow growth and persistent poverty (Carter *et al.*, 2014). In a context where more extreme weather events are predicted and technology to address threats is available, why some farmers are more prone to take action than others? Farmers anticipate that uninsured shocks will strike and adjust their behavior to reduce the expected consequences of shocks (Rosenzweig and Binswanger, 1993). Farmers may choose a preventive management and reduce the risk, or react after being affected to cope with the consequences of shocks.

Preventive actions involve reducing the risk, risk avoidance, risk transfer and risk retention. For example, reducing the risk requires investment in resilience (i.e. producer's ability to overcome the shock). Farmers avoid risks by investing in activities or practices with less risk but usually with low yields. Risk transfer can be formal (e.g. crop insurance) and informal (e.g. help from family and friends).

Risk perception has become an important topic to farmers, traders, politicians and policy makers concerned with risky investments. Given that risks are prevalent in our unsure world, adopting appropriate risk management strategies to deal with risk exposures and their consequences is an everyday mission. An important starting point is that, in some important instances, perceptions of risk do not appear to correlate with measurable probabilities of risk and therefore other factors are clearly important in understanding how people perceive risk and respond to it. This can have an important impact on the ability of policy makers and academicians to communicate risk analysis decisions in cases where such mismatches occur. It has been suggested that societies select particular risks for attention and that risks are therefore “exaggerated or minimized according to the social, cultural, and moral acceptability of the underlying activities” (Covello and Johnson, 1987).

Risk perception is the subjective assessment of the probability of a specified type of accident happening and how concerned we are with the consequences. Risk perception includes evaluations of the probability as well as the consequences of a negative outcome. Perception of risk goes beyond the individual, and it is a social and cultural construct reflecting values, symbols, history, and ideology (Weinstein, 1989). It follows from the specificity and variability of human social

existence that it should not simply be presumed that scores and ratings on identical instruments have the same meanings in different contexts (Boholm, 1998). Adams (1995) claimed that “the starting point of any theory of risk must be that everyone willingly takes risks”. He concluded that this was not in fact the starting point of most of the literature on risk.

Personal experience, memory and other factors influence the way people perceive risks and these may ignore the probability of the event’s occurrence – thus risk perception is socially constructed (Garvin, 2001). In addition, it appears that people have a level of risk with which they feel comfortable and will adjust the riskiness of their behavior in the presence of safety measures. Adams (1995) calls this tendency the individual’s “risk thermostat” and uses it to explain why people tend to drive faster when they have airbags and child restraints fitted in their cars.

Risk perception and risk management research is today becoming rather firmly established as a discipline in its own right. A lot is known about how supply chain actors perceive the diverse risks they confront in their daily activities as well as more distant hazards, how experts and lay people disagree on magnitudes and qualities of risks (Sjöberg and Drottz-Sjöberg, 1994), and we have some theoretical approaches as how to describe risk perception (e.g., Kasperson *et al.*, 1988).

Two distinct theories currently dominate the field of risk perception. One is the ‘psychometric paradigm’, rooted within the disciplines of psychology and decision sciences, whereas the other derives from ‘cultural theory’, developed by sociologists and anthropologists. One of the most important assumptions within the psychometric approach is that risk is inherently subjective. “Risk does not exist ‘out there’, independent of our minds and cultures, waiting to be measured” (Slovic, 1992). However, Wåhlberg (2001) argued that there is no as much risk perception theory around as we may think.

There are several other approaches to risk perception, such as Cultural Theory (Douglas and Wildavsky, 1982) and Simplified Conjoint Expected Risk (SCER) but for the sake of brevity, only three approaches are reviewed in this study. They are the psychometric approach of Slovic *et al.* (1985) the social amplification framework of Kasperson *et al.* (1988) and the Basic Risk Perception Model (BRPM) of Sjöberg (1993). In short, psychometric paradigm encompasses a theoretical framework that assumes risk to be subjectively defined by individuals who may be influenced by a wide array of psychological, social, institutional, and cultural factors. Psychometric paradigm

assumes that with appropriate design of survey instruments many of these factors can be quantified (Slovic, 1992). His examination of diverse groups showed that psychometric scaling can identify and quantify similarities and differences in risk perceptions and attitudes among groups (Slovic *et al.*, 1985).

The psychometric paradigm is an approach for identifying the characteristics influencing people's perception of risk (McDaniels *et al.*, 1995). The approach assumes that risk is inherently multidimensional, with many characteristics other than the probability of harm affecting individual judgments. Risk perception varies between respondents, dependent on the particular issue being evaluated and the definition of risk used to elicit responses. Again, this suggests a coalition between psychometric paradigm and cultural theory. They also found that 'personality profiles' of hazards defined by the qualitative risk characteristics of the psychometric paradigm were not necessarily universal: different individuals will attribute different characteristics to the same risk issue.

The Basic Risk Perception Model (BRPM) of Sjöberg (1993) is a less eminent alternative to the psychometric approach. It incorporates and expands on the psychometric dimensions and explains more variance in risk perception (Sjöberg and Drottz-Sjöberg, 1994). It does this mainly by adding the factors of attitude, risk sensitivity, and specific fear, and sometimes trust (Sjöberg, 1992,) and moral value (Sjöberg and Drottz-Sjöberg, 1993). It would seem that the dimensions extracted in this kind of research are a bit more stable from study to study than those of the psychometric approach. The method used in research on this approach is similar to that of the psychometric, *i.e.* questionnaires, factor and regression analyses. The samples used are, however, much larger and more representative of the general population. Another important difference is that in the statistical analyses, the individual is used as the unit of analysis, not the mean of responses, as it is in the method used by Slovic *et al.* (1986).

The social amplification theory conceptualizes risk partly as a social construct and partly as an objective property of a hazard or event (Renn *et al.*, 1992 as cited in Wåhlberg, 2001). This means that, it is not possible to know whether in a given moment, the term social amplification refers to, for example, information, actions by companies, or risk perception by individuals. The founders of this approach claim that it is an advantage not to make these kinds of distinctions: 'To treat risk as both an objective property and a social construct avoids the problems of total relativism on one

hand and of technological determinism on the other hand.

According to Marris *et al.* (1997) the psychometric paradigm assumes that risks have ‘personality profiles’. This implies that all individuals assess hazard in the same manner. The approach treated risk, activities, and products as “external objects with a set predefined qualities and drawbacks, and ignored the possibility that social, cultural and institutional factors might affect the way in which risks are understood and evaluated by individual members of the public” (Turner and Wynne, 1992). Hence, they pointed out the usefulness of combining psychometric paradigm with cultural theory. This has also been supported by Belaineh (2002) stating risk perception variability cannot be explained by one single theoretical framework, suggesting the importance of using multiple theoretical frameworks for a better understanding and analysis of risk. In conclusion to the theoretical review, it is pertinent to consider multiple risk perception theories or approaches and risk management strategies for this study.

2.2.3. Theoretical perspectives of new institutional economics

According to Olson and Kahkonen (2000) new institutional economics (NIE) refers to the expansion or “sub-urbanization” of economics as a whole. As a result of the expansion of economics into other social sciences, NIE is by definition a multidisciplinary field of study. Fields such as the so-called “new economic history” and the public choice school inform the institutional environment at the macro level while transaction cost economics and information economics for example inform more the micro analytical aspects of transactions and the forms of governance. Figure 3 gives a graphical depiction of these fields and the main academic contributors to each.

New economic history

North (1990) pioneered the New Economic History in an attempt to explain how economies evolve and develop through time. This is considered the more macro aspect of the NIE, which looks at the role of institutional change in fostering overall economic growth and explaining the divergence in the development of various countries. According to North (2005), institutions (he equates institutions to the institutional environment, i.e. the set of political, social and legal ground rules) that evolve to lower transaction costs are the key to the performance of economies.

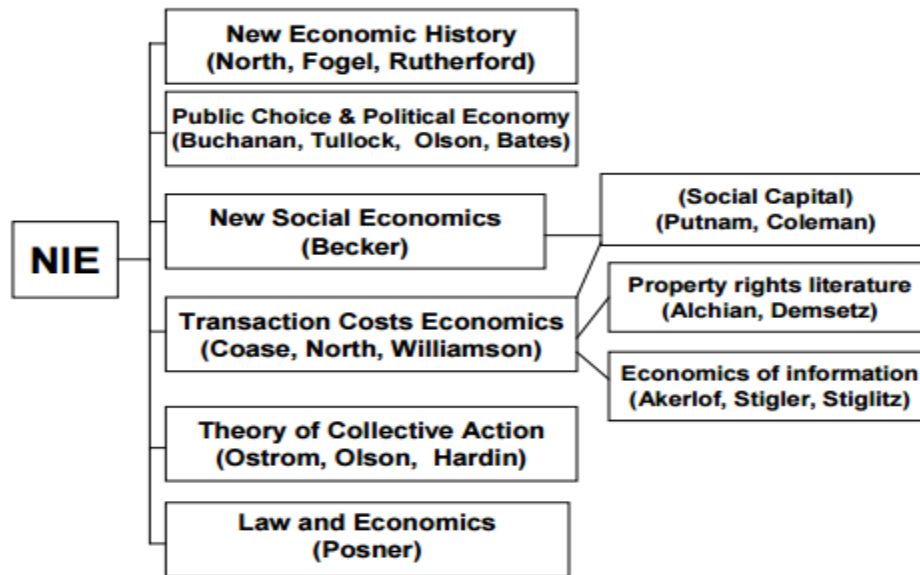


Figure 3: Branches of new institutional economics

Source: North (1990)

Public choice and political economy

This branch of NIE is illustrated in the early work of Buchanan and Tullock (1962) on the economic analysis of political systems and political decision-making. Olson (1971) analyzed rent-seeking behavior and interest group dynamics to explain why some economic outcomes are less than economically efficient. In particular, Bates (1981) explains the bias against the agricultural sector in developing countries (especially Africa) as a result of a more politically active urban constituency demanding cheap food policies.

New social economics

The work of Becker and Murphy (2000) on intra-household analysis, family economics, and human capital was a major breakthrough in explaining choices that were made outside the market and that were previously not addressed by neoclassical economics. Putnam's (1993) work on social capital also falls within this framework, but social capital is also incorporated in transaction cost economics as an important element in cutting down the costs and uncertainty of market exchange. Social capital refers to social connections or networks, norms and trust, all of which can facilitate cooperation in society and ultimately have effects on economic performance (Putnam, 1993;

Ensminger, 2000). It is now increasingly being recognized that social connections and networks should be studied to explain economic behavior and organization.

Theory of collective action

The theory of collective action includes work by Olson (1971) on the manner in which interest groups use collective action to reach common goals. It is a useful tool to analyze how to overcome free-rider problems with cooperative solutions for the management of common resources or the provision of public goods. According to Olson (1971), important determinants of success in collective action include the size, homogeneity and purpose of the group. An important field of investigation in the theory and application of collective action concerns the use of “common-pool resources” such as water, land, fisheries, forests, etc. In the past, the solution to the so-called “tragedy of the commons” was the establishment of enforceable property rights over the resources. However, recent work by Ostrom (2005) and others has shown that local institutional arrangements including customs and social conventions designed to induce cooperative solutions can overcome the collective action difficulties and help achieve efficiency in resource use (Nabli and Nugent, 1989).

Law and economics

The application of economic analysis to the study of laws and regulations has led to the important field of “law and economics”, the best known advocate of which is Posner (1998). Posner (1998) studied the use of various legal instruments such as regulations, litigation, and legal decisions, using a theoretical economic approach, and viewing players in the legal system as rational actors who attempt to maximize their returns from legal action and regulations.

Economics of information

As indicated earlier the transaction cost economics school and the literature on the economics of information are not mutually exclusive. The economics of information literature includes seminal papers by Akerlof (1970), and Stiglitz (1985). Stiglitz’s (1985) main point is that searching for market information is not costless, which may explain why a divergence of prices between efficient markets is possible, and why capital markets are “imperfect”. Akerlof (1970) explained how quality

guarantees, reputation, and trust are useful tools to ensure the production of quality goods and a good reputation. Stiglitz (1985) also analyzed the role of imperfect information, adverse selection, and moral hazard, on the performance of credit and labour markets, and the behavior of the firm. The imperfect information theory has been used to explain the emergence of key agrarian institutions that are seen as substitutes for missing credit or insurance markets in an environment of pervasive risk, information asymmetry, and high transaction costs (Bhardan, 1989). This includes institutions such as sharecropping, interlocked contracts between labour, credit and land lease and etc. According to Bhardan (1989), under a set of informational constraints and missing markets, a given agrarian institution may be serving a real economic function. Therefore, abolishing this institution may not necessarily improve the conditions of the intended beneficiaries.

Property rights

The role of property rights is also accounted for in the NIE. According to Coase (1960), externalities can be internalized if property rights are well established. In Coase's view, if property rights are well established and if there are no transaction costs, an externality can be internalized between two private parties through bargaining and negotiations. This is the essence of what has been labelled the "Coase Theorem." Coase's argument was used to counter Pigou's call for government taxes to curb negative externalities. Kherallah and Kirsten (2002) showed that government involvement is in fact not necessary if property rights are well established. He also showed that the outcome would be efficient regardless of who owns the property right. The distribution aspects of the outcome, however, will depend on the initial allocation of the property rights. In the presence of transaction costs, on the other hand, different systems of property rights may yield different outcomes in terms of efficiency as well as equity.

Property rights issues are also embedded in the incomplete contract theory pioneered by Grossman and Hart (1986), Hart and Moore (1999). The incomplete contracts economic theory of the firm combines the insights of transaction cost economics regarding the importance of bounded rationality and contracting costs with the rigor of agency theory. The new theory focuses on the way different organizational structures assign property rights to resolve the issues that arise when contracts are incomplete. This provides a basis for defining different organizational structures by the ownership and control of key assets. Incomplete contract theory predicts that asset ownership

has an effect on parties' incentives to invest. This effect is due to the impossibility of writing comprehensive contingent contracts for relationship-specific investments and the resulting potential for opportunistic behavior and *ex post* re-negotiation of the trade benefits. This risk of hold up leads to under-investment. Changing the allocation of asset ownership between the trading parties may solve (part of) the hold-up problem. The second best ownership structure choice assigns most power to the party generating the highest surplus.

Transaction cost economics

The general hypothesis of this strand of the NIE is that institutions are transaction cost-minimizing arrangements that may change and evolve with changes in the nature and sources of transaction costs. Coase (1937) pioneered this work when he argued that market exchange is not costless. He underlined the important role of transaction costs in the organization of firms and other contracts. Transaction costs include the costs of information, negotiation, monitoring, coordination, and enforcement of contracts. He explained that firms emerge to economize on the transaction costs of market exchange and that the "boundary" of a firm or the extent of vertical integration will depend on the magnitude of these transaction costs.

The work of Williamson (2009) on the economics of organization and contracts follows Coase's (1960) line of thinking. Williamson (2009) has combined the concepts of bounded rationality and opportunistic behavior (which manifests itself as adverse selection, moral hazard, cheating, shirking, and other forms of strategic behavior) to explain contractual choice and the ownership structure of firms. In Williamson's (2009) framework, a trade-off has to be made between the costs of coordination and hierarchy within an organization, and the costs of transacting and forming contracts in the market. This trade-off will depend on the magnitude of transaction costs. The focus here is thus on the costs of doing business, at the heart of which is the making, monitoring and enforcing of contracts. The ease or difficulty of contracting, and the types of contract made are determined by the level and nature of transaction costs, which are influenced by the extent of imperfect information involved in making a transaction. Transaction cost economics seeks to understand the interplay between institutional factors and market and non-market exchange under positive transaction costs.

The contribution of Ronald Coase, in his classic 1937 paper on "The Nature of the Firm," marked

the starting point of the recognition of the role of transaction costs in the theory of the firms. According to him transaction cost economics (TCE) is a study associated with costs that depend on the nature of the commodity and that of the transaction. According to Williamson (1985) transaction cost economics is an approach for the study of economic systems and organizations. TCE offers a set of normative rules for choosing among alternative governance arrangements which lies in that organizing transaction involves costs (Ménard, 2001) and governance structure affects transaction cost economizing result (Williamson, 1998).

Transaction cost economics (TCE) is a helpful theory to explain farmers' decision on different governance structures (GS). They differ according to the way in which exchanges or institutional arrangements are organized in terms of contracts regime, incentives and control regimes. According to Williamson (2009), TCE focuses predominantly on the governance of ongoing contractual relations. TCE is based on an integrated perspective of institutions, the law and economics (Rao, 2003). The major move towards TCE, as Williamson (1989) suggested, is to assign attribute differentiated transactions to governance structures in a transaction-cost-minimizing manner. Transaction costs were interpreted broadly as the comparative costs of planning, adapting, and monitoring task completion under alternative governance structures. From the transaction cost theory (TCT) perspective, the rational farmer will chose governance structure that is best performing in minimizing the production and transaction costs (Williamson, 1985).

In another perspective, North (1990) described these as 'the costs of measuring the valuable attributes of what is being exchanged and the costs of protecting rights and policing and enforcing agreements'. These definitions indicate the prior focus of TCE on the institutions and evolution of governance structures in relation to the role of transaction costs. In other words, TCE primarily focuses on the costs involved in making transactions rather than the costs of producing a product. Production cost for a particular task/function is the cost of performing that task, and is borne by the firm performing it. Several factors affect production costs including resource requirements, scale effects, and buyer experience. However, transaction costs are known as the costs allocated to write, monitor, and enforce the contract. These costs include the costs of running a market-based system, or the costs associated with the allocation of tasks to external agencies or outsourcing (Bello *et al.*, 1997).

According to Williamson's (1991) work, transaction cost framework, the magnitude of the transaction costs is determined by some key attributes including specific investments, level of uncertainty, bounded rationality and connectedness of the transaction. In NIE chain participation is linked to a choice on how to transact (or not transact) a product using a specific "governance structure". Governance is viewed in terms of the design of the particular mechanisms supporting an economic transaction where there is an exchange of property rights. TCE tries to derive the optimal governance structure under a certain set of situational contingencies (Barney and Hesterly, 1999).

The details of firm and market organization are limited under lens of choice setups, the lens of governance describes each generic mode of governance (market, hybrid, hierarchy) as a distinct syndrome of attributes, each of which differs in incentive intensity, administrative control, and contract law respects (Williamson, 2009). The choice is made among different "governance structures" and it is deeply affected by institutions. Under TCE reasoning, a continuum of three major forms of governance structures, ranging from spot-market and hybrid exchanges to vertical integration known as hierarchical governance structure, are distinguished (Figure 4). Hybrid forms of governance structures include bilateral contracts (classical, neo-classical and relational contract arrangements), networks (collective trading, partnership) and alliances (cooperatives, joint venture).

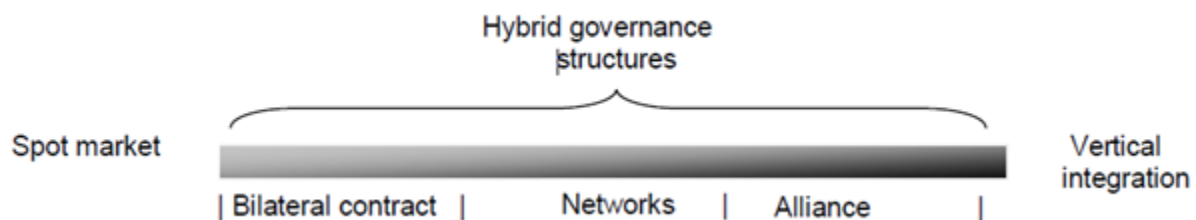


Figure 4: Continuum governance structures in the chain

Source: Menard (2004)

Following Williamson's (1985) work, in case of a high level of collaboration and relationship between buyer and seller the GS were close to the vertical integration mode, whereas in cases of lower levels of relationship, the GS were close to the spot-market mode. In the TCE framework, the costs of any transaction comprise the *ex ante* and *ex post* costs.

Ex-ante costs are incurred before and during the transactions, such as search costs, information costs, and the costs of negotiating and developing a contract or agreement. *Ex post* costs are the

costs that rise after the transactions, such as the costs of monitoring and enforcing contracts or agreements (Williamson, 1996). *Ex-post* transaction costs, also known as coordination costs among organizational theorists (Douma and Schreuder, 2002), are resources utilized for creation, including the maintenance, and the use of institutions and organizations (Furubotn and Richter, 2000).

Following the insights of Coase (1937), Williamson (1985) has elaborated tools for exploring the mechanisms of governance based on these contributions, a significant amount of knowledge has accumulated about the different structures that can support and secure transactions. Several factors influence the choice of a mode of governance structure by actors involved in a transaction. The anticipated complexity of decomposing tasks among partners and of coordinating across organizational boundaries is a major factor in the choice of a specific mode of governance and in the design of mechanisms for monitoring the arrangement (Gulati and Singh, 1998).

Institutions refer to a broad range of meanings and are often used confusedly. North (1990) has been one of the first scholars to link institutions and economic performance. The works of Davis and North (1971) and North (1990) are quite enlightening to understand how institutions affect economies and economic agents. He distinguishes between the institutional environment and institutional arrangements.

The institutional environment sets the rules of the game of human interactions and the institutional arrangements are the players of the game. The institutional environment can be either formal (public, legal, governmental) or informal (social, moral). Institutions enable, constrain and direct human interaction (Nelson and Sampat, 2001). They reduce uncertainty by setting the rules of the game and hence creating a stable structure to human interaction allowing decreasing transaction costs. Several authors have argued that the relative importance of formal institutions increases as the scope of market exchange broadens and deepens (Dixit, 2004). One reason is that setting up formal institutions requires high fixed costs but low marginal costs, whereas informal institutions have high marginal costs. Informal institutions rather refer to norms of behavior, conventions, self imposed codes of conduct, reputation, etc.

The influence of the institutional environment on the choice of a governance structure is still unclear in the literature (Ménard, 2004). Regarding the number of parties to be included in the arrangement that involves a difficult trade-off between bilateral and multilateral agreements, chain

actors have to make a decision. The bilateral arrangements are easier to monitor but involve higher dependency; while the multilaterals make the management of the relationship more complex, but allow comparisons and benchmarking, a powerful tool for constraining opportunism. However, as for how interactions are undertaken among agents, North (1990, 1991) has insisted on the importance of the rules of the game for understanding how actors play that game, choosing ways to organize transactions. The present study will explain the influence of an enabling institutional environment such as institutional support, trust, capacity building, quality attributes of coffee, market information, etc. and how these can influence the coffee growers' choice of one (or more) governance structure in coffee supply chain.

Williamson (1991) went a step further in introducing the possibility of shifts in parameters that could explain changes in the mode of governance at the micro level. Based on Williamson's model, Oxley (1999) has developed an econometric test, showing how the legal definition and the implementation of property rights significantly influence the choice between equity and market-based contracts in hybrid arrangements designed for transferring technologies.

Economists started with a dichotomist view between systems based on decentralized decisions and systems planned from the centre, expressed in various but similar ways: "markets and plans" (Coase, 1937), "markets and hierarchies" (Williamson, 1975), "hierarchies and polyarchies" (Sah and Stiglitz, 1986). As confirmed by Grandori (1997), a third type of governance form has been added: clans (Ouchi, 1980), trust (Bradach and Eccles, 1989), networks (Thompson *et al.*, 1991; and many others), and constitutional ordering (Sabel, 1993). These categorizations have been proposed, but they are difficult to compare properly with the two types of markets and hierarchies (Grandori, 1997). Therefore, the growing literature on the class organizations known as hybrid forms of governance structure, standing between markets and hierarchies, raises important questions about their nature and role in a market economy.

Taken together, most of the reviewed literatures provide considerable support for the main propositions derived from transaction cost economic theory. The central hypothesis is that as portrayed on Figure 4, governance structure choice is largely determined by institutional factors and transaction specific attributes. Thus, in this study the transaction cost economics theory of the NIE, underpins the relationships between independent variables and the choice of governance structures.

2.3. Methodological and Analytical Frameworks

2.3.1. Technical efficiency analysis

The pioneer work on efficiency was begun by Farrell in 1957 from which the present estimation method originated. Over time estimation of the production frontier has tended to follow two general paths; the full frontier where all observations are assumed to be along the frontier and the deviation from the frontier considered being inefficient. The other path has been the stochastic frontier estimation where the deviation from the frontier is attributed to the random component reflecting measurement error and statistical noise and an inefficiency component (Ogundele and Victor, 2006).

The estimation of full frontier has been based on either non-parametric approach where technical efficiency is estimated by solving the linear programming for each individual farm/firm or through parametric approach where the estimation is by statistical techniques (Coelli *et al.*, 2005). Empirical studies on efficiency usually utilize either Data Envelopment Analysis (DEA) or SFA. DEA is a non-parametric approach and employs linear programming to construct a piecewise-linear, best-practice frontier for each economic unit (Fare *et al.*, 1985). In DEA analysis of efficiency, no functional form for the production frontier is imposed on the data. However, most non-parametric programming approaches to production frontier estimation consider production to be deterministic and by assumption do not allow the possibility of noisy data. The major drawback of analyzing efficiency using DEA is that since it forces all outputs to a frontier it is sensitive to outliers that largely distort efficiency measurements and hence, all deviations from the frontier are considered to be due to technical inefficiency (Coelli *et al.*, 2005; Ogundele and Victor, 2006).

Some researchers have dealt with this issue by introducing elements of statistical analysis into DEA models (Simar and Wilson, 2000). However, because stochastic specification of the production frontier model explicitly accounts for random shocks that affect production but lie outside producer control, SFA is a more appropriate approach for an environment characterized by considerable random effects and because of functional flexibility. The linear and Cobb-Douglas forms are the first order flexible, where as other forms have second order flexible (Coelli *et al.*, 2005).

The stochastic parametric method, however, incorporates the random error of regression. The

random error therefore captures the effect of unimportant left out variables and errors of dependent variables as well as the farm specific inefficiencies. It is because of this decomposition of error that makes this method of estimation superior to others. It provides the farm efficiency estimates with much lower variability than any other method due to the term decomposition (Neff *et al.*, 1994). What should have been its major weakness as opposed to non-parametric measurements was its inability to construct different frontier for every observation (Ogundele and Victor, 2006).

However, this was later overcome by measuring the mean of the conditional distribution of inefficiency (μ_i) given the random error (ε_i) (Jondrow *et al.*, 1982). Neff *et al.* (1994) who stated that “while the ability of stochastic frontier to incorporate random disturbance term to account for events beyond management’s control is appealing, the need to use an estimate to measure inefficiency may result in very similar farm efficiency estimates”. For this study, the stochastic frontier method was used to analyze the technical efficiency of coffee farmers in south western part of Ethiopia.

Production function estimation has been criticized in recent times that it results into simultaneous equation bias leading to wrong conclusions (Akinwumi and Kouakou, 1997). In such cases, estimation of technical efficiency using product and input prices has been advocated. It is because of the above proposition that this study adopted production function analysis to estimate technical efficiency. However, Neff *et al.* (1994), contends that prices in a given region are always homogeneous and uniform across farms. And as such, “differences in efficiency measures are likely to reflect quantity, not price difference.”

The assumption here in estimating production frontier is that all coffee farmers in the sample use the same technology. The data underlying the study consist of observations on the quantities of inputs employed and the output provided by each farmer for the maintenance of matured coffee trees only. Since coffee is of long gestation period, factors of production employed capture those that farmers applied for the maintenance of matured coffee trees during the last coffee production season.

Thus, this study employed a stochastic frontier analysis (SFA) which requires a parametric representation of the production technology. In addition, output oriented measure of technical efficiency were applied in this study.

Based on the specification of Jondrow *et al.* (1982) the stochastic production function for the cross-sectional data can be written as follows:

$$Y_i = f(x_i; \beta) TE_i \quad (1)$$

Where Y_i is the scalar output of producer i , $i = 1 \dots N$, X_i is a vector of K inputs used by producer i , $f(X_i; \beta)$ is the stochastic production frontier, β is the parameters to be estimated, and TE_i is the output-oriented technical efficiency of producer i . Hence based on the equation (1) technical efficiency, which is also supposed to have stochastic distribution, of specific farmer can be derived as follows.

$$TE_i = \frac{Y_i}{f(x_i; \beta)} \quad (2)$$

Equation 2 reveals that technical efficiency is the ratio of observed output to frontier output (maximum output feasible under the current technology used). Y_i achieves its maximum value if and only if $TE_i = 1$. Technical inefficiency occurs when $TE_i < 1$. Frontier function in an econometric model is classified as either deterministic frontier model or stochastic frontier model according to assumptions about the composed error term and the way that inefficiency is defined (Coelli, 1995). In equation (1) the production frontier $f(X_i; \beta)$ is deterministic. Nevertheless, the stochastic production frontier comprises error term (technical inefficiency and random shock outside the control of farmers). According to Aigner *et al.* (1992), the stochastic frontier can be written as:

$$Y_i = f(x_i; \beta) \cdot \exp(v_i)' \cdot TE_i \quad (3)$$

With this specification TE for the specific farmer, which is also expected to take stochastic distribution, can be derived based on the work of Aigner *et al.* (1992) and Coelli (2005) as follows:

$$TE_i = \frac{y_i}{f(x_i; \beta) \cdot \exp(v_i)'} \quad (4)$$

This is the output oriented TE measure that is the ratio of observed output (Y_i) to maximum feasible output. Even though both deterministic and a stochastic production frontier function helps to estimate technical efficiency score for each farmer under consideration, deterministic frontier by Aigner *et al.* (1992) is less flexible and the inefficiency score resulted is entirely an outcome of deviation from frontier production function and it does not recognize composed error term. Having

understood this in literature, an attempt was made to specify production frontier in form of stochastic function. This is more flexible than deterministic approach (Aigner *et al.*, 1977). Therefore, this study uses the stochastic production frontier specification, in which error term is expected to have stochastic distribution, identically and independently distributed to each other, and the mean of inefficiency indicator is derived at truncation of zero mean and $\delta^2 u$ variance (Jondrow *et al.*, 1982; Coelli, 1995).

Following the inadequacies of deterministic frontier estimation, three sets of researchers (Aigner *et al.*, 1977; Meeusen and Broeck, 1977; Battese and Corra, 1977) simultaneously and independently developed the stochastic production frontier methodology. The stochastic frontier estimation involves the specification of the disturbance term that causes actual production to deviate from this frontier by decomposing it into two parts as follows:

$$\psi = \varphi(\xi, \beta) \varepsilon^{v-u} \quad (5)$$

Where v is a symmetric, normally distributed ($v \sim N(0, \sigma^2 v)$) component representing the random effect of statistical noise and stochastic events or exogenous shocks beyond the control of the producing unit (for example, environmental factors such as bush fire, temperature and moisture), and u is a one-sided component intended to capture the effect of technical inefficiency (TI). If $u = 0$, production lies on the stochastic frontier and production is technically efficient; if $u > 0$, production lies below the frontier and is inefficient.

The stochastic frontier method requires a prior specification of the most widely used functional forms like Cobb-Douglas and Translog. Cobb-Douglas is a special form of the translog production function where the coefficients of the squared and interaction terms of input variables of translog frontier are assumed to be zero. The Cobb-Douglas production function (in spite of its restrictive properties) is preferred because its coefficients directly represent the output elasticity of inputs and easy for interpretation and estimation than translog frontier (Coelli *et al.*, 1998; Seymoun *et al.*, 1998).

The translog functional form includes second order terms and interactions between the input variables. This functional form is useful in approximating a wide range of production technologies and is a useful approximation to almost any production function (Christensen *et al.*, 1973). Translog

frontier is susceptible to multicollinearity even if it is more flexible form (Thiam *et.al*, 2001). Cobb-Douglas is a special form of the translog production function where the coefficients of the squared and interaction terms of input variables of translog frontier are assumed to be zero. The Cobb-Douglas functional form imposes constant production elasticities and a constant rate of substitution on the data. In fact, this functional form is one of the most widely used in the economic analysis of problems related to empirical estimation in agriculture, regardless of its restrictive in empirical applications (*e.g.* Villano and Fleming, 2004).

The Cobb-Douglas production function (in spite of its restrictive properties) is preferred because its coefficients directly represent the output elasticity of inputs and easy for interpretation and estimation than translog frontier (Coelli and Battese, 1998; Seymour *et al.*, 1998). Most of the studies estimated technical efficiency using the stochastic frontier production function approach (Bravo-Ureta and Rieger, 1991). Following works of these authors, the stochastic parametric model using Cobb-Douglas production function with maximum likelihood estimation method has been given preference in this study to analyze the technical efficiency of smallholder coffee growers for the reasons stated above.

2.3.2. Determinants of technical inefficiency

There are two main approaches that help to examine determinants of technical in/efficiency from stochastic production function, namely: one step approach and two step approach. The one step approach comes to exist after independent and simultaneous work of Kumbhakar *et al.* (1991). To them, inconsistency is being created between error component model and production efficiency effect model of stochastic frontier estimation and in identifying factors affecting production efficiency indicators. They developed a procedure in which all parameters are estimated using maximum likelihood procedure. Nevertheless, unlike the ordinary least square (OLS) method, maximum likelihood would follow the same assumptions for distribution of u_i in estimation of stochastic production frontier and u_i which were regressed up on the determinants of technical efficiency. Yet, from the characteristic of likelihood function it is difficult to identify local maximum as long as there are many ups and downs (Coelli and Battese *et al.*, 1996).

In the one-step approach, the error component model and technical efficiency effect models are

estimated in one step maximum likelihood estimation approach. Technical efficiency effect model according to Coelli and Battese (1996) is specified as ($u_i = \delta z_i + w_i$). Where u_i is vector of farmer specific technical efficiency calculated using maximum likelihood estimation (MLE), z_i is the vector of factors affecting technical efficiency of specific farmer i and δ is a vector of parameters to be estimated, and w_i is the random terms assumed to be independently and identically distributed. It is defined by the truncation of the normal distribution with zero mean and unknown variance $\delta^2 w$ such that u_i is a one sided distribution (non-negative) (Coelli, 1995).

Investigating inefficiency in a two-stage procedure uses the stochastic production frontier model to estimate the efficiency scores. In the second stage, the efficiency scores are regressed on a set of explanatory variables (Lovell, 1993). This approach can be traced to Timmer (1971) who used it in an attempt to explain variation in technical efficiency in U.S. agriculture.

In the two step approach, we first estimate the error component model from stochastic frontier function to determine technical efficiency levels. Subsequently, technical inefficiency thus obtained is regressed on explanatory variables that usually represent the firms' specific characteristics (technical efficiency effect model), using OLS method or Tobit model. In this approach, the value of technical efficiency estimate is predicted using Jondrow *et al.* (1982) procedure. However, this approach has a shortcoming emanating from inconsistency that could be created from the assumptions related in the distribution of u_i in the estimation of technical inefficiency effect model and error component model. In the estimation of error component model, technical inefficiency of farmer i (u_i) are assumed to be normally, independently and identically distributed. Thus, in this study, the censored Tobit model estimation has been given preference over OLS to identify factors affecting technical inefficiency of coffee production.

2.3.3. Analysis of risk perceptions and risk management strategies

Risk assessment about the sources of major agricultural risks and risk management strategies are important to smallholder coffee growers and depend on how the risk is perceived. Risk perception involves peoples beliefs, attitudes, judgments and feelings, as well as the wider social or cultural values that people adopt towards hazards and their benefits. The way in which people perceive risk is vital in the process of assessing and managing risk. Risk perception will be a major determinant in whether a risk is deemed to be "acceptable" and whether the risk management measures imposed

are seen to resolve the problem.

Various agricultural sources of risks can be mitigated if smallholder farmers understand the sources of risks and its impact on their performances. Risk sources of the coffee farm business should be identified based on perceptions of actors in the chain. It is also important for the smallholder coffee growers to understand that their risk susceptibility is dependent on other constituents of their farm and other socio-economic factors.

While numerous reports may identify selected risks, there is a need for a more systematic assessment highlighting patterns of risk exposures from various risky events for smallholder coffee growers. This stage of the assessment results in a number of key outputs *e.g.* a presentation of the risk profile of smallholder coffee farmers, and coffee suppliers and as well as the documentation and summary of key informant interviews. This involves interviewing representatives of major coffee supply chain actors (*i.e.* farmers, and wholesalers) as well as conducting focus group discussions with additional service providers (*i.e.* farm extension advisers, financial institutions and staffs of ECX).

Present literature shows that there is no agreement about the most appropriate methods to describe sources of risk and risk responses on farms. Kukeawkasem (2008) studied sources of risk and risk management strategies among 408 swine farmers in northern Thailand. Multiple and logit regressions were employed to examine the relationship between farmers' risk attitudes and sources of risk and socio-economic characteristics of the farmers. However, the Likert-scale rating method has been regularly applied in risk perception researches. In most of those studies, the respondents were asked to rate the sources of risk that had affected their farm and the risk management strategies they use on a five-point scale.

Aditto (2011) used multiple regression analysis to investigate the relationship between farmers' socio-economic characteristics and their perceptions about sources of risks and risk management strategies. In our study, sample households were asked to rank the five major sources of agricultural risks using Likart scale in terms of importance (1 being the least important and 5 as the most important). In this study, to examine the relationships between farm, household and socio-economic characteristics, with the sources of risk an ordered probit model has been employed, where as risk management strategies were analyzed using multivariate probit models.

2.3.4. Governance structure choices

Fontana and Geuna (2010) investigated the reasons why different governance modes are used in a sample of successful collaborative patenting activities in Europe. To study the determinants of the choice of a specific governance mode they carried out two types of analysis. First they estimated a multinomial logit regression. Second, on the basis of the result of the first part of the analysis and to provide a robustness check, they developed a further set of estimations applying an ordered probit model.

Similarly, Olmos *et al.* (2009) analyzed the relationship between product quality and governance mode choice (market mode, hybrid mode or vertical integration) using the results of a survey of 187 qualified appellation of origin Rioja wineries. By estimating a generalized ordered logit, they concluded that wineries that produce high-quality wines are more likely to vertically integrate than are wineries that produce low-quality wines.

Imre and Gabor (2002) investigated the choice of farmers among various supply channels in Hungarian fruit and vegetable sector employing the framework of transaction cost economics. They applied a multinomial logit model to reveal the determinants influencing the choice among various supply channels. However, these models are applied when the assumption about the independence of observations and the dependent variable should have mutually exclusive and exhaustive categories are full field. Thus, it has been difficult to assume farmers choice of various supply chains that are mutually exclusive and exhaustive since they can supply their produce via more than one supply channel.

In cognizant to the stated assumption Arinloye *et al.* (2010) used a multivariate probit model to analyze the determinants of governance structure in the pineapple supply chain in Benin. Their finding depicts that the specificity of the investments, transaction connectedness, market stability, institutional support and market attributes are key factors that determine smallholder pineapple farmers' choice of governance structure. To identify the key drivers influencing the supply chain vertical coordination, thereby affecting its governance structure and to assess the impact of the improvement options on the governance structure, Cosimo *et al.* (2010) used confirmatory and exploratory factor analysis.

Similarly, to identify factors affecting governance structures among smallholder coffee growers, the present study employed a Trivariate probit using GHK (Geweke-Hajivassiliou-Keane) simulation.

2.4. Empirical Literature

2.4.1. Technical efficiency

By applying stochastic frontier one step approach, Battese and Coelli (1995) examined factors that influence the technical inefficiency of Indian farmers using panel data. The study estimated error component model and technical efficiency effect model using the software called Frontier 4.1c. The technical efficiency effect model showed that farm size, farmer's age and educational level of farmers as the main important determinants of technical efficiency of Indian farmers. The mean technical efficiencies of those farmers are 0.73, 0.74 and 0.71 respectively, for the villages of Aurelle, Kanzara and Shirapur.

Temesgen and Getachew (2016) analyzed the technical efficiency of coffee production on smallholder farmers in Sasiga and Limu districts of east Wollega zone. They conducted the study using cross-sectional data collected in 2013/14 production year from a total sample size of 200. The parametric stochastic production frontier (SPF) model using Cobb-Douglas production function was used by the authors to analyze the TE of coffee production. The mean technical efficiency for coffee production was about 88 percent. The econometric results pointed out that labour and land are significant and negatively affect TE. The negative sign imply that efficient farmers have employed lower amount of land and labour inputs. They also found that seed and oxen are significant and positively affect TE; implying efficient farmer has higher units of oxen and seed. Increased distance between plots was found positive and significant. Female headed households are more efficient than male headed households. Actually it has been difficult to accept the results of some variables like distance between plots and seed. For instance, how seed as an independent variable entered in the model is quite difficult to understand because it could not be possible for a farmer to recall the amount of seed used long years ago (For example 38 years ago as it was the average age of coffee tree among the samples).

Poudel *et al.* (2015) compared the technical efficiency of organic and conventional coffee farms in Nepal using DEA approach. Their study used a two-step methodology. First, data envelopment

analysis (DEA) was used to model technical efficiency in variable inputs management; second, the farm specific variables such as age, family size, education, training, and gender were used to assess variations in farm inefficiency with a Tobit regression framework. They collected a primary data from random samples of 240 (120 from each) coffee farms. The mean technical efficiency score was 0.89 and 0.83 in organic and conventional coffee farming respectively. They found that variation in technical efficiency was related to education, farm experience, training/extension services and access to credit for the conventional coffee farms.

Shumet (2011) analyzed the technical efficiency of crop producing smallholder farmers in Tigray region, Ethiopia using a stochastic frontier analysis. He found that the mean technical efficiency of farmers is 60.38% implying that output in the study area can be increased by 39.62% at the existing level of inputs and current technology by operating at full technical efficient level. In his study, the estimated stochastic frontier production function revealed education of household heads, family literacy, family size, share cropping, credit access, crop diversification, and land fertility are found to enhance efficiency. In contrast, households' age, dependency ratio, livestock size, and non-farm activity are found to increase inefficiency.

Similarly, the study on the factors affecting technical efficiency of Indian Paddy by Battese and Coelli (1995) found a positive relationship between the degree of inefficiency and the producer's age, and a negative relationship between the degree of inefficiency and the educational level of the producer. Following their work they concluded that government must give *priority* settings towards educational investment. However, their work is limited in excluding some important variables used in output and technical efficiency modeling like rainfall, access to credit, and agricultural extension service. The main advantage of their work is that they contributed significant work towards efficiency study as they are the first to undertake technical efficiency study using one step approach and Frontier 4.1c developed by Coelli (1996).

Using a stochastic frontier approach which is used to estimate an input distance function and evaluate production efficiency, Cardena *et al.* (2005) tried to estimate technical efficiency of coffee producers in Mexico. Factors such as coffee quality and access to markets are tested in terms of their effects on technical efficiency. Results show that the production process in these municipios, as measured by technical efficiency, appears to be stable over time despite price fluctuations in the

global market. Production of staple crops (corn) along with coffee resulted in lower efficiency. Factors contributing to higher efficiency included higher population density, production of specialty crops other than coffee or staple crops, and higher altitude, which is typically associated with production of higher quality coffee. These findings can be then considered part of an effort that can be extended to contribute to creation of suitable policies focused at a regional or district level.

The study by Amadou (2007) analyzed factors influencing the technical efficiency of Arabica coffee farmers in Cameroon. To carry out this analysis he used a Translog stochastic production frontier function, in which technical efficiency effect model and error component models were estimated using the one step maximum-likelihood method. The data used were collected from a sample of 140 farmers during the 2004 crop year. The results obtained show some increasing returns to scale in coffee production. The mean technical efficiency index is estimated at 0.896, and 32 percent of the farmers surveyed have technical efficiency indexes of less than 0.91. The result also reveals that the educational level of the farmer and access to credit are the major socioeconomic variables influencing the farmers' technical efficiency. The study also found that further productivity gains linked to the improvement of technical efficiency may still be realized in coffee production in Cameroon.

Most recently, Thong *et al.* (2014) estimated the technical efficiency of coffee production and identified factors affecting the technical efficiency of smallholder coffee farmers in the Krong Ana Watershed of the DakLak province in Vietnam. Using a stochastic production frontier, the estimated mean technical efficiency score was 0.68 for the three combined districts (Krong Ana, Krong Bong and Lak). Concerning factors determining TE of coffee production, they found formal education of the household head, amount of financial credit obtained, ethnicity, coffee farming experience of the household head, and agricultural extension service were positive and significantly increase technical efficiency in coffee production.

2.4.2. Risk perceptions and risk management strategies

Some authors dealing with the issue of risk perception Borges and Machado (2012) focused on finding factors determining differences in the level of risk perception. They concluded that these differences are determined by the socio-economic features of the farmers and the characteristics of their farms. Thus, appropriate risk perception can be seen as a prerequisite for choosing an effective

risk-coping strategy, because a farmer that is not aware of the risks faced is clearly unable to manage them effectively. This problem was discussed, among others, by Pennings and Leuthold (2000).

The literature of risk behavior (risk perceptions and risk management) of smallholder coffee growers' is particularly lacking. Therefore, empirical and theoretical studies available in related fields are considered to motivate the theoretical analysis of this study. In fact, theoretical arguments and available empirical evidence elsewhere, among others, suggest that farmers have heterogeneous perceptions of risks influencing their business or livelihood (Smith *et al.*, 2001). Differences in risk perceptions among individuals depend on a combination of socioeconomic, demographic, biophysical, institutional and other contextual factors (Meuwissen *et al.*, 2001).

Meuwissen *et al.* (2001) studied survey data of Dutch livestock farmers relating to farmers' perceptions of risk and risk management using multivariate regression, and analyses whether characteristics of a farm and/or farmer can be identified that relate to these perceptions. The results showed that, in general, price and production risks were perceived as important sources of risk. Insurance schemes were perceived as relevant strategies to manage risks. Exploratory study to provide empirical insight into how the mussel farmers manage risks in their businesses was conducted by Ahsan and Roth (2009). The results of the study indicated that changes in public regulation, human risks and market risks are the high ranked risks in mussel farming. On the other hand, experience sharing among the farmers, good relation with government and solvency are considered most important risk management strategies.

Some research on supply chain risk has been performed in agricultural sector. Szèp *et al.* (2000) explored the importance of the different sources of risk related to horticultural production in horticultural farms of Hungary. Possible ways to prevent the occurrence or reduce the possible negative effects of risk and behavior of horticultural producers faced with different kinds of risks were examined. The statistical analysis of survey results showed that high rank of price (input-output), market risks, and counterpart risk were risk sources of horticultural production in horticultural farms of Hungary. Growing several types of plants, contract in selling products, join some integration, and non-farm investment were used as the ways to prevent the occurrence or reduce the possible negative effects of risk.

Bogges *et al.* (1985) examined farmers' awareness of risk in crop and livestock production in northern Florida and southern Alabama. The respondents were asked to define risk and then to rank the sources of risk and risk management strategies based on how important each risk was to their farm. The results showed that most respondents defined risk as the probability of a negative outcome. The respondents ranked rainfall variability, pests and diseases, and crop price variability as the primary sources of risk for crop production. Livestock price and weather variability and livestock diseases were perceived as important sources of risk for livestock production.

Patrick *et al.* (1985) studied farmer attitudes towards risk and risk management among mixed crop and livestock farmers in the US. A total of 149 farmers in 12 states were interviewed. The respondents were grouped into five types of farm; mixed farming; cotton; corn, soybean and hogs; small grain and ranch. The results showed that changes in weather, output price and input costs were rated as the three most important sources of risk in both crop and livestock production. Similarly, Hoang and Nguyen (2015) identified and analyzed yield risk and price risk using a value chain approach among smallholder coffee growers in the central highland areas of Vietnam. Their results show that the first most important source of risk to the smallholder farmers that has been recognized is market or price risk, pointing out significant impact on business of farmers with high probability of occurrence. The second important source of risk likely incurred by smallholder farmers is the production or yield risk caused by drought and rainfall variability.

Using a nationwide mail survey, Martin (1996) examined the sources of risk and the risk management strategies of New Zealand farmers. His survey covered eight types of farm including sheep and beef, dairy, deer, pip fruit, kiwifruit, cropping, vegetables and flowers. The results showed that marketing risk (such as change in product prices and change in input costs) was ranked as a very important source of risk by all farmers. Conversely, production risks (such as rainfall variability, weather, and pests and diseases) were regarded differently depending on geographical location, farm type and product. Pellegrino (1999) studied rice farmers' perceptions of the sources of risk and risk management responses in Argentina. Using size of the respondents' farms (large, medium, and small farms), the author argued that a farmer's awareness of the sources of risk varied depending on farm size. The small size farm group tended to have a higher awareness of production risks than the other two groups.

Meuwissen, *et al.* (1999) identified price and production risks as the most important sources of risk for livestock farmers in the Netherlands. An insurance scheme was rated as the appropriate strategy to manage risk. Flaten *et al.* (2005) compared risk perception and the risk responses of conventional and organic dairy farmers in Norway. The results revealed that the institutional (such as government support policies) and marketing risks were classified as the principal sources of risk for the organic dairy farmers. The author's ranked production cost variability and animal welfare policy as the greatest worries for conventional dairy farmers. A study by Nicol *et al.* (2007) large-scale South African sugarcane farmers perceived land reform regulations, labour legislation and crop price variability as the three most important risk factors.

In terms of risk management strategies, Boggess *et al.* (1985) and Patrick *et al.* (1985) reported that 'obtaining market information' and 'enterprise diversification' were the most important strategies that the sampled crop and livestock farmers use to handle risk in the US. Meuwissen *et al.* (2001) found that 'cost of production' and 'insurance schemes' were regarded as important risk strategies among livestock farmers in the Netherlands. Similarly, Flaten *et al.* (2005) also noted that organic and conventional dairy farmers perceived 'increasing farm liquidity', 'disease prevention', 'buying farm insurance' and 'cost of production' as the most important strategies used to deal with risk on their farms in Norway. On the other hand, New Zealand farmers used a mix of risk management strategies to reduce risk. The strategies varied among the groups of farmers depending on the nature of the product, market structure and conditions, farmer characteristics, dynamic risk adjustment considerations and the regulatory situation (Martin, 1996).

Ngamsomsuk *et al.* (2006) examined risk perceptions among rice farmers in Payao and Lampang provinces in the northern part of Thailand. In their study, the Participatory Risk Mapping (PRM) technique was used to elicit sources of risk. The authors' results showed that rice farmers in Payao faced five major sources of risk including 'outbreak of rice disease', 'insects causing damage to rice', 'high input costs', 'flooding', and 'shortage of water supply'. Farmers in Lampang typically faced 'drought', 'insects and pests causing damage to rice', 'low output prices', and 'high input costs'.

Aditto *et al.* (2012) tried to see the relationships between the socioeconomic variables and the perception of risk sources and risk management strategies of the smallholder farmers in the central

and northeast regions of Thailand. They employed multiple regression analysis to investigate the relationship between farmers' socioeconomic characteristics and the perceptions of sources of risk and risk management strategy. The authors result indicated that marketing risks associated with 'unexpected variability of input prices' and 'unexpected variability of product prices' had the highest and second highest mean scores for sources risk, respectively rated by the farmers in the regions.

Moreover, Borges and Machado (2012) studied the factors determining differences in the level of risk perception. They found that risk perception differences are determined by the socio-economic features of the farmers and the characteristics of their farms. They further asserted that appropriate risk perception can be seen as a prerequisite for choosing an effective risk-coping strategy, because a farmer that is not aware of the risks faced is clearly unable to manage them effectively. This problem was also discussed, among others, by Pennings and Leuthold (2000).

2.4.3. Governance structure and transaction cost economics

There has been little systematic empirical analysis of agriculture or the organization of agriculture transactions from a transaction cost perspective. Masten (1993) notes, however, that agricultural transactions display a broad range of governance structures, including the location specific nature of the investments required and the temporal specificities associated with the perishability of agricultural products.

The existing few empirical studies examine the extent and use of long-term contracting in agriculture. Allen and Lueck (1992a; 1992b) studied the use of relatively simple short-term contracts in farming and argue that the simplicity of these agreements reflects the comparative advantage of enforcing farmland contracts through the market and common law. The authors suggest that the character of the farming economy – good information about reputations, the immobility of farmers and landowners, relatively low transaction costs and the desire to maintain long-term relationships – lends itself to the pervasive use of informal, simple contracting. Purcell and Hudson (2004) examined the growth of long-term contracting, the rise of vertical alliances, and the prevalence of integration between feedlots and beef processors brought on by the site specificity that exists.

As Masten (2000) noted agricultural transactions provide a rich and largely unexplored area for application and refinement of transaction-cost theory. That might soon change, for as Allen and Lueck (2000) stated that agricultural economists, with their knowledge of farming, are well positioned to take advantage of the fertile ground of economic organization. As is true of other disciplines, empirical research within agriculture will not only benefit from a transaction cost economic approach, but also help to broaden and advance the theory itself.

The majority of empirical research in transaction cost economics is a variation of the discriminating alignment hypothesis (Williamson, 1979). The most common empirical approach is to conceptualize organizational form as one of three broad discrete types: market, hierarchy, or various hybrid and intermediate modes. Hybrid modes of governance include joint ventures (Klein, 1999), relational contracting, and bilateral governance (Heide and John, 1990). Oxley (1999) in particular examined the proliferation of different governance modes in alliances, creating a market-hierarchy spectrum that ranges from unilateral contractual agreements (*e.g.*, one-sided licensing agreements, long-term supply contracts and R&D contracts), to bilateral contractual agreements (*e.g.*, technology sharing or cross-licensing agreements, joint research agreements) to equity-based alliances (*i.e.*, joint ventures).

The probability of observing more (less) integrated forms of organization depends upon the underlying properties of the transaction. More integrated governance modes are associated with a higher degree of relationship-specific assets, greater uncertainty (including but not limited to customer, supplier or technological uncertainty), more complex transactions, or more frequent exchange. Of the transactional properties that have been examined empirically, asset specificity, or the transferability of assets that support a given transaction to a different user, is argued to be the most important (Williamson, 1985) and had subsequently seen the most proliferations in the empirical literature. Measures of asset specificity in empirical TCE research are broad, often subjective, and include the physical proximity (*i.e.* site specificity) between contracting parties (Joskow, 1990), idiosyncratic investments, product complexity, inter-firm co-specialization, and spatial or temporal proximity (Meehan *et al.*, 1991).

A study conducted by Joskow (1989) had moved a general understanding of the significance of transaction costs in explaining the choice between firms and markets and issues associated with the

internal organization of the firm, to a fairly specific theory for explaining the structure of vertical relationships based on variations in the importance of asset specificity, uncertainty, product complexity, and the constraints of repeat purchase activity. Imre and Gabor (2002) investigated the choice of farmers among various supply channels in Hungarian fruit and vegetable sector employing the framework of transaction cost economics. Their analysis is based on a survey among 62 fruit and vegetable producers in Csongrád county of Hungary in respect to the choice of marketing channels. They identified four marketing channels which differ in the costs of using them: wholesale markets, marketing cooperatives and producer organizations. They found that most of the institutional and transaction specific variables did not significantly influence farmers' choice of supply chains. Thus, their result seems to contradict some of the basic propositions of transaction cost economics.

Farmers feel safer in a market setting where they maintain long-term relationships with their buyers (Lu, 2007). Moreover, farm size is expected to have a positive relationship with farmers' decision process as shown by Polson and Spencer (1991). This leads to hypothesize that large scale farmers who are located far away from the market place were likely to be involved in long-term relations and more integrated governance structures.

Menard (2004) stated that the likelihood of contract-based arrangements is even higher when weak uncertainty combines with investments that cannot be redeployed for another transaction. This may lead the farmers to choose an integrated form of governance structure in order to protect their investment. It can therefore be assumed that the greater the human and asset specificities, the more likely the actors were involved in an integrated form of governance structures.

Monteverde and Teece (1982a) examined empirically the role of asset specificity in determining the structure of vertical relationships. Empirical research that applies transaction cost theory in an economic setting examines whether and when particular contracting practices provide efficiency benefits. A large body of the early empirical work in this area was focused on two phenomena: vertical integration and long term contracting. Similarly, a study by Arinloye *et al.* (2010) on the pineapple supply chain in Benin identified additional market type governance structures, and three other types of governance structure falling into the hybrid class namely relational based governance structure, outgrowing schemes, and the farmers' organization type of governance structure. Their

results also showed that the specificity of the investments, transaction connectedness, market stability, institutional support and market attributes are key factors affecting the choice of governance structure among pineapple farmers.

Fundamental to TCEs explanation as to whether economic agents procure critical inputs and services through internal production or via market transactions is the role of asset specificity. The earliest empirical work of Joskow (1985) focused on the presence of relationship-specific investments as the critical determinant of the vertical integration decision. An important outcome of his study was an appreciation for the various types of specific investments that have organizational consequences.

2.5. Conceptual Framework

This section describes the concepts of technical efficiency, governance structure choices from transaction cost economics perspective, risk perceptions and risk management strategies. To address the objectives and the research questions identified in the preceding chapter, a conceptual framework is developed to serve as a guide for developing hypotheses that were tested by this study. Also, the conceptual framework attempts to portray how these key concepts and variables are interrelated and interwoven.

Efficiency is an engineering concept for measuring the performance of a system given the available resources. Production efficiency is associated with behavioral objectives of maximization of output (Battese and Coelli, 1995). However, this production objective cannot be carried out in isolation since a farm can be considered as an economic unit with scarce resources. When a producer with the aim of maximizing profit makes allocation mistakes that result in inefficiency, then the farmer is considered allocatively inefficient (Kumbhakar, 2004). Therefore, technical efficiency cannot be achieved in isolation but other considerations (efficiencies) are always at play.

Conceptually, efficiency measurement attempts to identify those factors that are farm specific which hinder production along the frontier. Production efficiency goes beyond evaluation based on average production to one that is based on best performance among a given category though it is related to productivity where inputs are transformed into outputs (Battese and Coelli, 1995). Secondly, efficiency measurement provides an opportunity to separate production effects from

organizational and institutional dimensions of production. The concept of efficiency of farms has widely been studied by a number of researchers.

As can be seen from the conceptual framework depicted in Figure 5, production efficiency depends on socio-economic variables such as (credit utilization, membership in a cooperatives, level of education, and mobile ownership), farm characteristics, household characteristics, coffee management practices, and natural and physical characteristics. This study, therefore, investigates the production efficiency of coffee growers given different factors contributing to efficiency differentials among coffee producers in south-western part of Ethiopia.

Risk in agriculture is pervasive and complex, especially in agricultural production (Hazell and Norton, R., 1986; Hardaker *et al.*, 2004). Farmers confront a variety of yields, unstable output and input prices and changes in production technology as inherent in their farming operations. These affect the fluctuation in farm profitability from season to season and from one year to another. The sources of risk and level of its severity can vary according to the farming systems, geographic location, weather conditions, supporting government policies and farm types (Dunn *et al.*, 2002). The types and severity of risks that farmers face differ from place to place. Thus, incorporating and understanding smallholder farmers' perceptions of risk sources at household level will benefit policy makers to develop appropriate risk management strategies that can help farmers survive the numerous risks they confront.

In rural areas, households experience a wide variety of shocks and face many risks. Some of these shocks are particular to a household (idiosyncratic shocks), but others affect entire towns, sectors of economic activity, or countries, such as natural disasters (systemic shocks/covariate). Second, these households have differential access to the tools that allow them to manage risk and cope with the consequences of shocks. Rural households not only have differential access to financial and insurance markets but also to other risk-coping mechanisms, such as informal financial transactions, migration and remittances. Patrick and Musser (1997) concluded that, besides geographic location and farm type, institutional structures and other factors affecting the operating environment of producers were also likely to influence farmers' perceptions to sources and responses to risk sources.

It is important to be aware of that all people, irrespective of their role in society, employ provisional

frameworks to make sense of the world and selective judgment in their responses to risk. These so called ‘non-rational’ factors are not necessarily incorrect. However, there are likely to be significant differences in these understandings and responses, and such divergences are critical to understanding how best to manage and communicate about risks occurring to the coffee sector.

Given the limited amount of research particularly in the study area, it is not yet clear whether smallholder coffee growers have significantly different perceptions of risk than other parts of society. There are still mixed opinions about how socio-demographic factors influence risk perceptions, but it is generally agreed that farmers tend to be risk averse (Harwood *et al.*, 1999). And their perceptions to risk will be influenced by a range of situational factors and knowledge, beliefs and attitudes. These perceptions will also influence the likelihood of farmers’ up-take different risk management strategies. Therefore, success of a range of agricultural policies and programs that are designed to increase productivity and sustainability is clearly dependent on understanding how smallholder coffee growers’ perceive different sources of risk and how those perceptions help determine their risk management responses.

As indicated in the conceptual framework, Figure 5, households’ perceptions to major sources of risk and risk management strategies they consider are determined by socio-economic variables, farm characteristics, household characteristics, natural and physical characteristics. Moreover, in this study, technical efficiency of smallholder growers is expected to determine households’ perceptions to sources of risks.

In the conceptual framework, Figure 5, an attempt is made to dissect how the three main determinants of transaction costs and institutional factors and market characteristics in addition to the complexity of the transaction are expected to influence the smallholder coffee growers’ choices of governance structures. Moreover, the perceived quality of coffee and socio-economic factors do affect governance structural choices of smallholder coffee growers’.

Thus, the key conceptual move to TCE as indicated by Williamson (1998) is to describe firms not only in neoclassical terms (as production functions) but also in organizational terms (as governance structures). The basic insight of TCE is to recognize that in a world of positive transaction costs, exchange agreements must be governed, and that, contingent on the transactions to be organized, some forms of governance are better than others.

Figure 5 portrays the different factors that are hypothesized to affect the choice of a particular type of governance structure among smallholder coffee growers. These include (1) the socio-economical characteristics of smallholder coffee growers, (2) the transaction attribute (including asset specificity, uncertainty, and connectedness of the transactions) and (3) the institutional environment.

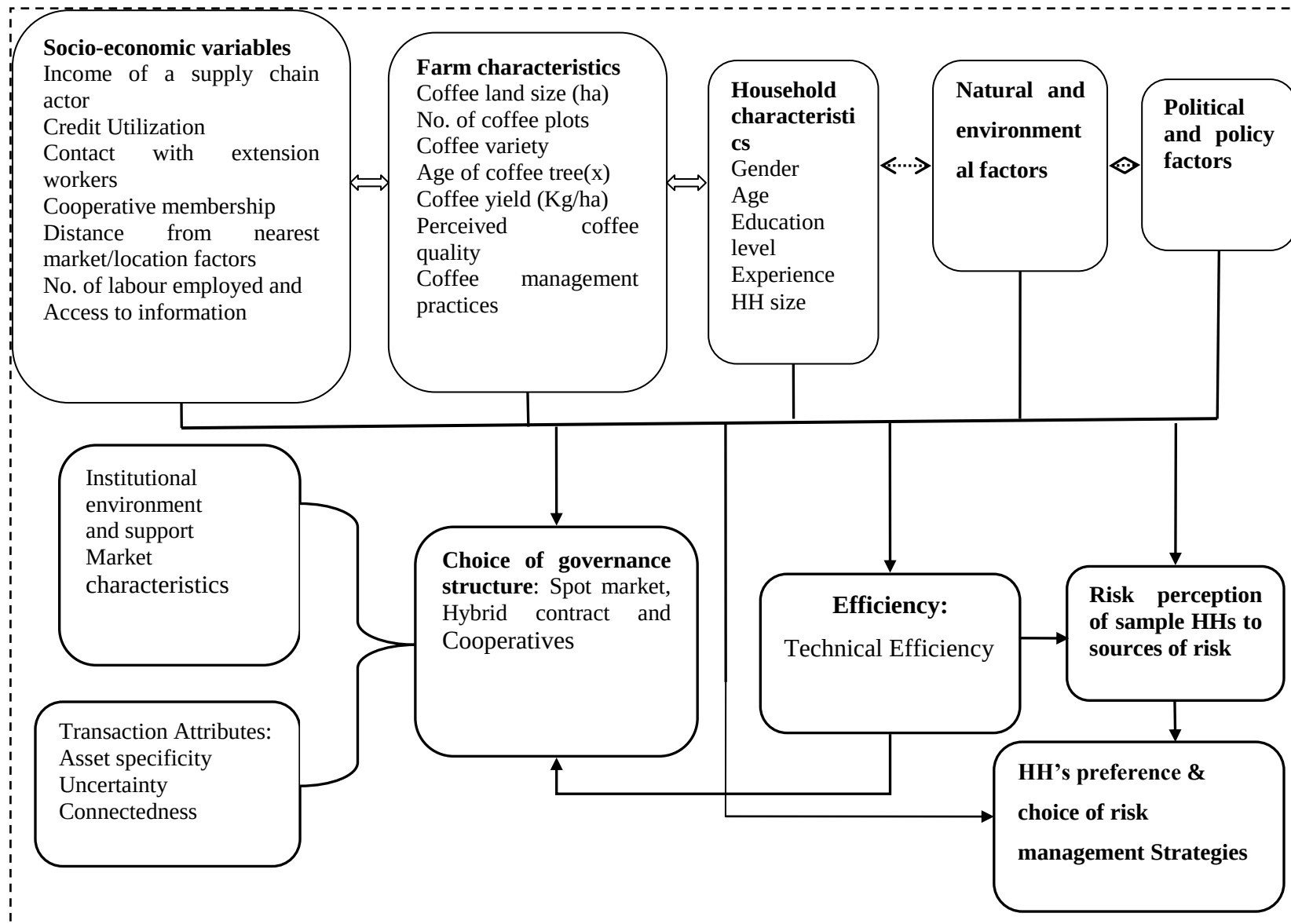


Figure 5: Conceptual framework of the study

3. RESEARCH METHODOLOGY

This chapter describes where and how the research was conducted. These include: description of the study area, sampling technique, data collection procedures and methods of data analysis.

3.1. Description of the Study Area

Ethiopia is the center of origin and diversity of Arabica coffee. South-western coffee growing area of Ethiopia is indicated as the primary origin of the crop. According to CSA (2015), more than three fourth (79.35 percent) of the SNNPR's permanent crop area is under stimulant crops. Of the total area under stimulant crops in the region, 78.04 percent is that of coffee resulting in 66.93 percent of the volume of stimulant crop production. This study was conducted in Kefa zone of SNNPR. The Zone is selected based on the importance (the contribution) in coffee production to the region. Of the zonal (Kefa) stimulant crop area, 92.31 percent was under coffee yielding 88.07 percent of the production of this crop. Coffee is an important cash crop in all Woredas of the Kefa zone.

3.1.1. Kefa zone

Kefa is located in the south-western part of Ethiopia, between 6° 24' to 7° 70' N and 35° 69' to 36° 78' E, some 460 km south-west of Addis Ababa. Kefa zone has a total area of 10,602.7 square kms and it lies at an altitude ranging from 500 to 3500 meters above sea level. According to CSA (2014/15) projections, the total population of the zone in 2015 is 1,053,777 persons with a population density of 99.4 persons per square km. Of the total population, 518,164 are men and 535,613 are women and 88.2 percent constitute a rural population.

Administratively, the zone is found under the SNNPR and is divided into 10 woredas, namely: Gesha, Chena, Gimbo, Menjio, Tello, Cheta, Bitu, Gewata, Saylem & Decha. With regards to agro climatic condition, out of the total area land mass, *Dega* shares 11.64 percent, *Weynadega* 59.45 percent, and *Kolla* shares 28.91 percent. The mean annual temperature of the zone ranges from 10.1 to 27.5°C and the mean annual rainfall of the zone ranging from 1001 to 2200 mm. Of the total land area, about 23.1 percent is cultivated, about 31.54 percent is forestland, about 6.03 percent is grazing land, 24.9 percent is cultivable land and the remaining being a marginal land. The agro ecological condition of Kefa zone is very suitable for growing coffee, tea, spices and other crops.

Bonga is the administrative center of the zone situated at a distance of 449 km south west of Addis Ababa and 80 km from Jimma. Topographically, it lies at an altitude of 1650 meters above sea level and has a *Woyenadega* type of climate. Its average annual rainfall is 1750 millimeters. Bonga town is one of the 22 towns identified as autonomous provisional city in the region. In order to facilitate the socio- economic development of the town, it is structured into 3 kebeles. The town has all infrastructure facilities vital for the implementation and operation of industrial activities. It has a tap water supply, electricity, banking, and telecommunication facilities. The main high way road that stretches from Jimma to Mizan town passes via Bonga town.

Coffee export from the Kefa region started as early as in the 1850s (Schmitt, 2006). At present, farmers produce garden coffee and wild coffee for home consumption and the international market. Coffee is their most important cash crop. They sell it to private traders or through the Kefa Forest Coffee Farmers Cooperative Union, which marketed around 130 tons of wild coffee in 2003/04. Private investors manage several small coffee investment areas in Kefa region ranging from 10 to 500 ha each, and there is one organic coffee plantation (1,000 ha).

The Zonal total area covered under coffee trees in the year 2014/15 is about 233,202 hectares of land. Of this land area, 49.71, 22.97, 21.69, and 5.64 percent of land is covered by garden, forest, semi-forest and large scale plantation of coffee production systems, respectively. Of the zonal land area covered under coffee trees, 154,333 hectare of land is covered under productive coffee trees. In the same year, the zonal total coffee production is about 804,081 quintal, of which 43.5, 18.35, 23.01, and 15.13 percent of coffee production is obtained under garden, forest, semi-forest, and plantation types of coffee production system (See Annex Table 2 & 3).

Based on Digital Rainfall Model classification, the traditional agro-ecological classification of the zone, with the exception of Southern Decha which is wet moist kolla, falls in the wet moist *woina dega* regime (Tezera, 2008). Details of the sample Woredas are presented below.

3.1.2. Decha woreda

Decha is one of the 10 woredas in kefa zone. The name Decha comes from one of the provinces in the former Kingdom of Kefa, which had approximately the same boundaries. Part of the Kefa Zone, Decha is bordered on the south by the Omo River which separates it from the Debub Omo Zone, on

the southwest by the Bench Maji Zone, on the northwest by Chena woreda, on the north by Gimbo woreda, on the northeast by Telo woreda, and on the southeast by the Denchya River which separates it from the Konta special woreda.

Based on the figures published by CSA (2015), this woreda has an estimated total population of 152,128 persons of whom 75,848 are men and 76,280 are women; 10453 or 6.87 percent of its population are urban dwellers, which is less than the Zone average of 11.8 percent. With an estimated area of 2,841.26 square km, Decha has an estimated population density of 53.54 people per square km, which is less than the Zone average of 99.4 people per square km. According to a 2007 report, Decha had 47 kms of all-weather roads and 5 kms of dry-weather roads, for an average road density of 18 kms per 1000 square kms. The southern tip of Decha is included in the territory of the Omo National Park.

The data obtained from Kefa zone agriculture reveals that the total area of Decha woreda covered by coffee trees in the year 2014/15 is about 34,003.14 hectares of land. Of these land area, 24,455.27 hectare of land is covered by productive coffee trees. Of the land area of the woreda covered by the productive trees, 39, 1, 54.1, and 5.9 percent of land is covered by garden, forest, semi-forest and large scale plantation of coffee production systems, respectively. In the same year, the total coffee production of the woreda is about 155,316.45 quintal of which 55.31, 0.46, 35.43, and 8.8 percent of coffee production is obtained under garden, forest, semi-forest, and plantation type of coffee production systems, respectively (see Annex Table 2 & 3).

3.1.3. Gimbo woreda

Gimbo (sometimes spelled Ginbo) is one of the woredas in kefa zone. The name Gimbo comes from one of the provinces in the former Kingdom of Kefa. That province, as well as the Kafficho provinces like Bonga and Manjo, became districts following the Menelik conquest in 1896, and these districts were later merged to form the current woreda.

Gimbo is bordered on the south by Decha, on the west by Chena, on the northwest by Gewata, on the north by the Gojeb River which separates it from the Oromia Region, and on the east by Menjiwo. Towns in Ginbo include Diri, Gojeb, Ufa and Wushwush. Ginbo surrounds Bonga town. The primary food crops include enset and maize; other staple foods include wheat and barley. Major cash crops

include coffee and tea; there is a large tea plantation at Wushwush. Notable landmarks include a Christian monastery 12 kms from Bonga which dates to 1550, and the Bonga Forest Reserve covering some 500 square kms of the surrounding hillsides.

Based on the CSA (2015) projection estimate, the woreda has a total population of 110,558, of whom 54,603 are men and 55,955 women; whilst 18,408 or 16.65 percent of its population are urban dwellers. The majority of the inhabitants (87.17 percent) are Ethiopian Orthodox Christians, 5.14 percent are Muslims, 4.01 percent are Protestants, and 3.14 percent embrace Catholicism.

The data obtained from Kefa zone agriculture reveals that the total area of Gimbo woreda covered by coffee trees in the year 2014/15 is 44,350.57 hectares of land. Of these land area covered by coffee trees, 35,784.06 hectare of land is covered by productive coffee trees. Of the land area of the woreda covered under the productive trees, 21.4, 35.4, 33.9, and 9.3 percent of land is covered by garden, forest, semi-forest and large scale plantation of coffee production systems, respectively. In the same year, the total coffee production of the woreda is 8,400,316.8 kg, of which 35.9, 21.24, 26.82, and 16.02 percent of coffee production is obtained under garden; forest, semi-forest, and plantation type of coffee production systems, respectively (see Annex Table 2 & 3).

3.1.4. Chena woreda

Chena is one of the woredas in kefa zone. The name Chena comes from one of the provinces in the former Kingdom of Kefa, whose administrative center had been at Wacha. Part of the Kefa Zone, Chena is bordered on the south by the Bench Maji Zone, on the west by Bitu, on the north by Gewata, on the northeast by Gimbo, and on the east by Decha.

Based on CSA (2015) projection estimate, the woreda has a total population of 190,790 people of whom 93,642 are men and 97,148 are women; while 22,266 people or 11.67 percent of its population are urban dwellers. The majority (43.62 percent) of the inhabitants are Protestants, 40.84 percent are Orthodox Christians, 7.95 percent practice traditional beliefs, where as 3.09 and 3.9 percent, are Muslims and Catholic, respectively.

The data obtained from Kefa zone agriculture reveals that the total area of Chena woreda covered by coffee trees in the year 2014/15 is about 40,295.79 hectares of land. Of these land area covered by

coffee trees, 24,123.44 hectare of land is covered under productive coffee trees. Of the land area of the woreda covered by the productive trees, 36.7, 57.6, and 5.7 percent of land is covered by garden, semi-forest and large scale plantation of coffee production systems, respectively. In the same year, the total coffee production of the woreda is about 7,191,360 kg, of which 60.6, 30, and 9.4 percent of coffee production is under garden, semi-forest, and plantation types of coffee production systems, respectively (see Annex Table 2 & 3).

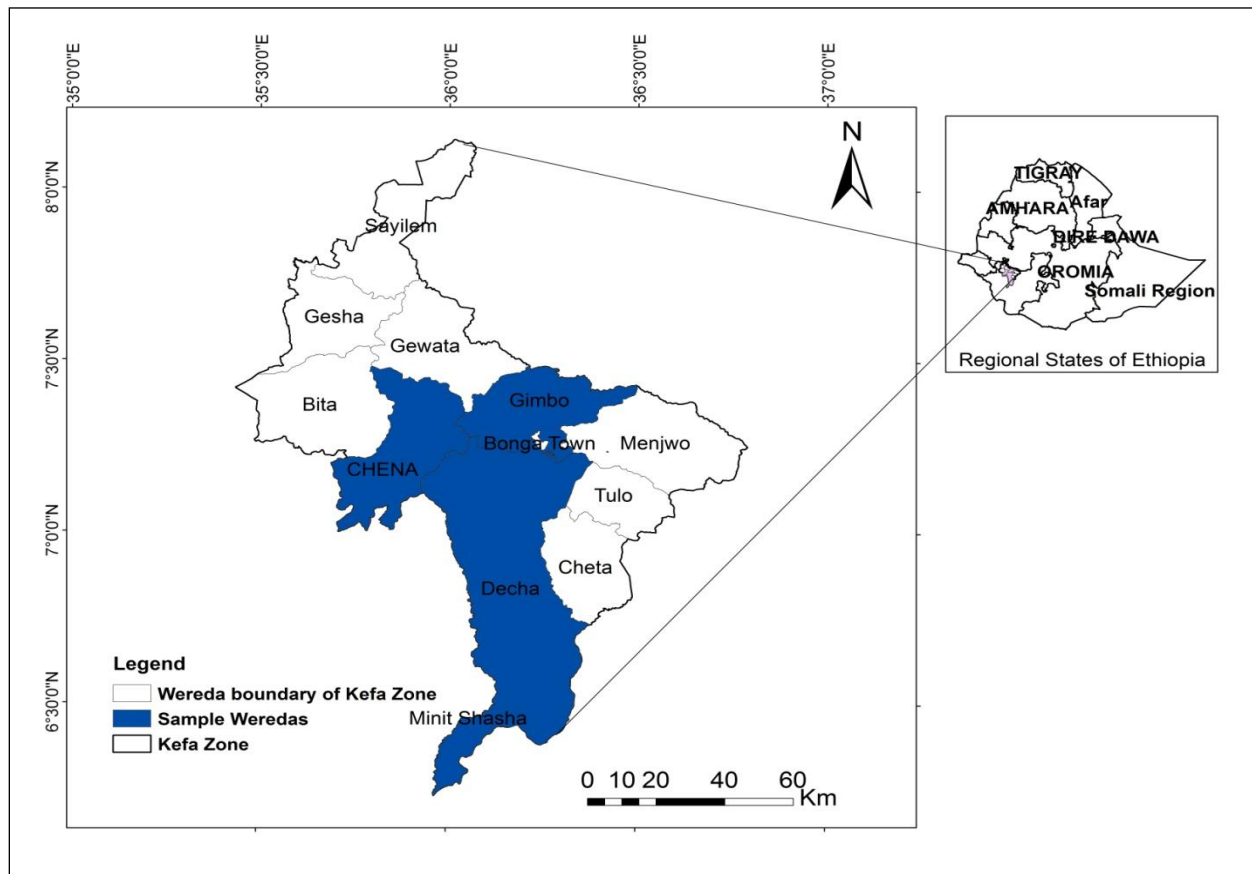


Figure 6: Administrative map of sample woredas of Kefa Zone, SNNPR

Source: Ethio-GIS, 2016

3.2. Data Types, Sources and Methods of Data Collection

Both primary and secondary data were used to collect the information required to address the objectives of this study. The data for this study were based primarily on cross-sectional data that are obtained from smallholder coffee growers, collectors (*sebsabies*), traders, and from both government and non-government actors who do have direct relation or have business in the coffee sector. The

secondary data were explored from different sources including ECX, kefa zone agricultural office, woreda agricultural and rural development offices of the three Woredas and from international coffee organization (ICO). SNNPR was selected because it is one of the areas where coffee is the most important cash crop and it has also been indicated in many literatures that there is immense potential for increasing coffee production in the region; however, the average per hectare yield remains low due to various factors.

The collected data includes factors of production (*i.e.* land, labor, fertilizer) that were used in coffee production, coffee yield, and output sold. The inputs enumerated are those type of inputs used in production and maintenance of matured coffee trees in the study areas. The data also includes selling and purchasing prices of coffee at primary coffee markets, major constraints and potentials identified by the samples in the areas of coffee production and transaction arrangements. Pertinent data on demographics, risk perceptions and responses, farm and non-farm activities, asset holdings, revenue from sale of coffee, transaction attributes (like asset specificity, frequency of transaction and uncertainty), actors' choice of governance structures, attitudes and perceptions about sources of risks are included.

The socio-economic, and demographic characteristics, which are believed to explain technical inefficiency of production, risk perceptions and governance structure choices were collected from smallholder coffee farmers and from coffee collectors who are involved in coffee trade at primary coffee markets. The socio-economic factors that were included in this study are educational level of a household head, experience of household head in coffee production/trade, income level, extension contact, proximity to market, distance from home to coffee plot, cropping system, access to credit, membership in cooperatives. Regarding institutional and transaction attributes, data on trust, frequency of transactions, bargaining power of actors, contract elements, institutional support, asset specificity, uncertainty and quality attributes were collected.

In this study, primary data were collected in November, 2015 using semi-structured interview schedule, key informant interviews and focus group discussions with smallholder farmers, collectors at primary coffee markets, relevant coffee regulatory agencies, and institutions that are engaged in coffee production and transactions. Focus group discussions were also conducted in consultation with

zonal and woreda officials. In addition, agricultural development agents and experts of ECX⁶ and intermediaries at different levels were consulted using key informants' interview and focus group discussions.

3.3. Sampling Technique and Sample Size

3.3.1. Sampling technique

Although coffee is grown in most regions of Ethiopia, Oromiya and SNNPR stand first and second in terms of coffee production and area cultivated respectively in the year 2014/15 (CSA, 2015).

A multi stage sampling technique was employed to collect the data. The study population is smallholder coffee growers, and collectors, along coffee supply chain in Kefa zone, South Western Ethiopia. Primarily all woredas in the zone were stratified into three strata based on the level of coffee productivity per hectare as high, medium and low. The cut-off points are determined by calculating the standard deviation of coffee productivity for all woredas of the zone using 2014/15 data obtained from Kefa zone, department of agriculture. And then average productivity $\pm$ one standard deviation is considered as medium productivity strata, productivity greater than one plus standard deviation is considered as a high productivity strata and productivity less than the average productivity minus one standard deviation is considered as low productivity strata. Thus, the average productivity is about 5.05 Qt/ha and the SD is about 1.21.

The three woredas were selected randomly among the three stratified levels of coffee production per household (High productivity strata if production per ha is greater than or equal to 6.26 Qt/ha; medium level productivity strata if the amount of coffee production per ha is greater than 3.84 Qt/ha and less than 6.26 Qt/ha and low level strata if production per hectare of land is less than 3.84 Qt). Based on the cut-off points, one from each stratum which is a total of three woredas were selected randomly from 3 strata which are classified as high, medium and low production levels per hectare. In the second stage, all kebeles in the sample districts were stratified based on agro-ecology (wet,

6 The Ethiopia Commodity Exchange (ECX) is an organized marketplace, where buyers and sellers come together to trade, assured of quality, quantity, payment, and delivery. The Exchange is jointly governed by private-public Board of Directors.

moist and woinadega) they are located in. Then, one kebele was selected randomly from each agro-ecology. In the third stage, household heads in the sample kebeles were randomly selected proportionally from agro-ecologically varied kebeles.

In addition, for the sake of triangulation, three FGDs and 10 key informant interviews (KIIs) in each woreda were conducted with Woreda agricultural experts, coffee growers, collectors, cooperatives, and unions operating in the study woredas.

3.3.2. Sample size determination

To determine representative sample size for smallholder coffee growers' survey, the study focuses on coffee growers in Kefa zone. Taking CSA (2010/11) estimate, there are 32,480 coffee growers in Kefa zone. Among these, the proportion of coffee growers in the sampled woredas comprises about 60 percent ($P=0.6$) of the total coffee growers in Kefa zone. Hence, for 95 percent ($Z=1.96$, a two tailed test) level of confidence, within ± 5 percent ($e=0.05$) margin of error and taking into account the proportion of coffee growers in three woredas of the zone, the sample size n was calculated using Daniel (1999) formula.

$$n = \frac{Z^2(1-P)P}{e^2} = \frac{1.96^2(1-0.64)0.64}{0.05^2} = 354 \quad (6)$$

From a total of 354 questionnaires distributed, 337 were completely filled in and returned back. As presented in Table 1 below, 137, 90, and 127 sample households from Gimbo, Decha and Chena woredas were drawn respectively based on the CSA (2010/11) coffee growers population data. Of the total samples, 7 from Gimbo and 10 from Chena woredas were missed. In addition, since the population of the intermediaries is too small, a sample of 41 coffee suppliers was randomly selected from the primary coffee transaction centers in the study areas.

Table 1. Number of sample households selected from each woreda and kebele

Districts/Strata		Sample kebeles	Sampled households				
			Total number of HHs	Sample propr.(%)	Sample size	Missed samples	Actual Samples
High Strata	production						
Gimbo woreda	Wet	Tula	9,865	14	48	3	45
	Moist	Beyemo	11,248	14	49	4	45
	Woinadega	Michiti	9,208	11	41	0	41
	Woreda Total		30,321	39	138	7	131
Medium Strata	production						
Decha Woreda	Wet	Baha	6,412	8	30	0	30
	Moist	Awash Kofira	5,217	8	29	0	29
	Woinadega	Awash Ola	7,808	9	30	0	30
	Woreda Total		19,437	25	89	0	89
Low Strata	production						
Chena Woreda	Wet	Beko	9,852	13	44	3	41
	Moist	Agaro	8745	11	40	4	36
	Woinadega	Dehara	9391	12	43	3	40
	Woreda Total		27,988	36	127	10	117
Grand Total			77,746	100	354	17	337

Source: Own computation result based on 2015 survey

3.4. Methods of Data Analysis

3.4.1. Descriptive statistics

To analyze data, descriptive statistics were used to describe the basic features of the data. They provide simple summaries about the sample and the measures. Specifically, first, descriptive statistics were used to assess the socio economic information of households and actors of coffee supply chain in the study areas. Then, different econometric techniques were employed using STATA 13 software package.

3.4.2. Econometric models

The Cobb- Douglas production function for this study is specified as:

$$\ln(\text{output}) = \beta_0 + \sum \beta_i \ln X_i + (v_i - u_i) \quad (7)$$

where output is the total quantity of coffee (whole dry cherry) produced measured in kg per hectare; $\ln$ is the natural logarithm; X_i 's are inputs whose quantities are under the control of the decision maker; X_1 represents the amount of organic compost used in quintals per hectare; X_2 represents the amount of coffee land area in hectares and X_3 represents the amount of labor used in man days per hectare. β_j 's $j = 1, 2, 3$ are the parameters estimated for the conventional inputs; and e is the error term defined as $e = (v - u)$. The decomposition of the error term into two components allows the deterministic frontier to vary across farms and therefore, the production frontier, $f(X_i, \beta) e^v$, is itself stochastic.

The technical efficiency relative to the stochastic production frontier $e - u = Y / [f(X_i, \beta) e^v]$ is captured by the one-sided error component $u \geq 0$. Assuming that the symmetric error is identically and normally distributed as $N(0, \sigma^2 v)$ and the non-negative error u is distributed as the absolute value of a normal distribution, $N(0, \sigma^2 u)$, that is half-normal, the population average technical efficiency can be calculated as:

$$E(e^{-u}) = 2\sigma \frac{\delta_u}{\delta_v} (1 - F^*(\delta_v)) \dots \dots \dots (8)$$

Where F^* is the standard normal distribution function. The log likelihood function for this system can be written as:

$$\ln(Y/\beta n \delta^2) = \frac{N}{2} \ln(2\pi) - N \ln \delta + \sum_{i=1}^N \ln[1 - F(e_i \lambda \delta^{-1})] - \frac{1}{2} \delta^2 \left(\sum_{i=1}^N e_i^2 \right) \quad (9)$$

Where $e = u_i + v_i$, and F is the standard normal cumulative distributive function.

Initial applications of the stochastic frontier model allow the average technical efficiency (inefficiency) to be estimated for the sample, but do not allow for the estimation of farm specific technical inefficiency. This is because individual residuals could not be decomposed into the two components, V_i and U_i . However, Jondrow *et al.* (1982) specified a decomposition method from the conditional distribution of u given e . Given the normal distribution of v , and the half-normal

distribution of u , the conditional mean of u given e is shown to be:

$$E(u/e) = \delta^2 * \{ f * (e^{\lambda/\delta}) / [1 - F * (e^{\lambda/\delta})] - e^{\lambda/\delta} \} \quad (10)$$

Where f^* and F^* represent the standard normal density and distribution functions, respectively, and $\delta^2 = \delta_v^2 + \delta_u^2$, where δ_v^2 and δ_u^2 represent the variances of the parameters of one-sided (u) and systematic (v), respectively. Therefore, total variance of output δ^2 can be expressed as $\delta^2 = \delta_v^2 + \delta_u^2$ or $\delta = (\delta_v^2 + \delta_u^2)^{1/2}$. The ratio of the two standard errors as used by Jondrow *et al.* (1982) is expressed as:

$$\lambda = \delta_u / \delta_v \quad (11)$$

This measures total variation of output from the frontier that can be attributed to production efficiency. The specification also enables the estimation of gamma⁷ (γ), the ratio of the variance of u to the total variances, $\gamma = \lambda^2 / (1 + \lambda^2)$ so as to determine, on the basis of the size of γ , whether the differences between the best and actual practices were actual or accidental. The smaller the ratio, the higher is the probability that the differences are accidental. With the assumption of half-normal model, a simple z-test will be used for examining the existence of technical inefficiency, the null and alternative hypotheses are: $H_0: \lambda = 0$ and $H_1: \lambda > 0$ (Coelli *et al.*, 2005). The test statistic is:

$$z = \frac{\bar{\lambda}}{s_e(\bar{\lambda})} \approx N(0,1) \quad (12)$$

where $\bar{\lambda}$ is the maximum likelihood estimator of λ and $s_e(\bar{\lambda})$ is the estimator for its standard error.

In order to determine the potential yield gap due to technical efficiency, from the stochastic model, TE of the i^{th} household is estimated to be:

$$TE_i = \frac{Y_i}{y_i^*} = \frac{f(x_i, \beta) \exp(v_i - u_i)}{f(x_i, \beta) \exp(v_i)} = \exp(-u_i) \quad (13)$$

Then, solving for Y_i^* , the potential yield of each smallholder coffee grower is represented as:

⁷ Gamma (γ) is the proportion of the total variance of the observed output from the frontier attributable to technical inefficiency. Gamma takes values between zero (0) and one (1) (Coelli, 2005).

$$y_i^* = \frac{Y_i}{TE_i} = f(x_i, \beta) \exp(v_i) \quad (14)$$

Where TE_i = technical efficiency of the i^{th} household in coffee production

Y_i^* = the frontier/potential output of the i^{th} household in coffee production, and

Y_i = the actual/observed output of the i^{th} household in coffee production.

3.4.2.1. Modeling determinants of technical inefficiency

The Tobit regression model was used to determine the relationships between farm and household characteristics, and technical inefficiency, which range from 0 to 1. If none of the values for technical efficiency are equal to 1 or zero, the Tobit model estimates converge to Ordinary Least Squares (OLS) estimates (Judge *et al.*, 1988). To facilitate the discussion, marginal effects were computed for each variable. Each marginal effect was interpreted as the percentage change in inefficiency resulting from a one percent change in the independent variable of interest. Given the functional specifications presented above, the technical inefficiency effects model for farmer i , and production technology indicated in (15) is defined as:

$$\mu = \delta_0 + \sum_{d=1}^n \delta_d w_d + \vartheta \quad (15)$$

where W_d is a vector of farm and household-specific variables that are expected to determine technical inefficiency levels, the δ_d 's are unknown parameters, and ϑ is a normally distributed random error term with mean zero and variance σ_u^2 , where σ_u^2 is defined such that $U_i \geq 0$. In the second step, the usual procedure to obtain standard errors is incorrect, if selection bias is present (Heckman, 1979). Therefore, standard errors of the production frontier can be adjusted using the Murphy-Topel estimate of variance (Murphy and Topel, 1985).

3.4.2.2. Modeling perceived sources of risks

As indicated in many literatures, the major sources of agricultural risks are production, market, financial, policy/institutional and human related risks. To measure perceived sources of agricultural risks of smallholder coffee growers, using a Likert scale of 1 to 5, the survey respondents (smallholder coffee growers) were asked to evaluate each of the five risks in terms of its importance

to their operation, with 5 being the most important or critical to the operation and 1 being the least important.

The dependent variables of interest are measures of perceived sources of risks, in which the household head ranks the five major agricultural risks in terms of their importance. The explanatory variables include demographic variables, farmers' characteristics, income, reasons for involvement in farm/marketing operation, information sources and preferences, resource management, households technical efficiency scores and their location.

The nature of the perceived risk rating variable is of the “ordered” type, and it takes ordered discrete values from 1 to 5. For “ordered” data, the suitable probability model is an ordered probit model. Since there are different types of risks, the empirical model is essentially a multivariate (5-variate) ordered probit model, to be estimated by using a Simulated Maximum Likelihood Procedure.

$$y^* = x' \beta + \varepsilon.$$

$$Y_{i1}^* = \beta'_1 X_{i1} + \varepsilon_{i1} + u_{i1},$$

$$Y_{i2}^* = \beta'_2 X_{i2} + \varepsilon_{i2} + u_{i2},$$

$$Y_{i3}^* = \beta'_3 X_{i3} + \varepsilon_{i3} + u_{i3}, \tag{16}$$

$$Y_{i4}^* = \beta'_4 X_{i4} + \varepsilon_{i4} + u_{i4},$$

$$Y_{i5}^* = \beta'_5 X_{i5} + \varepsilon_{i5} + u_{i5},$$

As usual, y^* is unobservable. What we do observe is

$$\begin{aligned} y &= 1 \text{ if } 0 < y^* \leq \mu_1 \\ y &= 2 \text{ if } \mu_1 < y^* \leq \mu_2 \\ y &= 3 \text{ if } \mu_2 < y^* \leq \mu_3 \\ y &= 4 \text{ if } \mu_3 < y^* \leq \mu_4 \\ y &= 5 \text{ if } \mu_4 < y^* \leq \mu_5 \end{aligned} \tag{17}$$

which is a form of censoring. The β 's are unknown parameters to be estimated. For the risk perception survey, the respondents will have their own intensity of feelings, which depend on certain measurable (farm, and socio-economic factors) and certain unobservable factors ε . The usual restrictions on the threshold parameters are applied for each equation. The random components $\varepsilon_i =$

$(\varepsilon_{i1}, \varepsilon_{i2}, \dots, \varepsilon_{i5})'$ are assumed to be independent, identically distributed with standard normal distributions. Thus, conditioned on u_{im} , each equation defines an ordered probit model. The additional set of random terms, $u_i = (u_{i1}, u_{i2}, \dots, u_{i5})$ are assumed to be distributed as multivariate normal with mean vector 0 and correlation matrix R . In principle they could respond to the questionnaire with their own y^* if asked to do so. Given only, say j possible answers, they choose the cell that most closely represents their own feelings on the question.

The relationships between the perceptions of risk against farm, farmer and socioeconomic characteristics were explored using ordered probit regression methods. In this regression analysis, the ordered discrete factor scores about the five major sources of agricultural risks were regressed on sample households' farm and socio-economic characteristics to identify the influence of these characteristics on the actors' perceptions of risk sources. Specifically, the regression models can be represented in the form of equation (16) indicated above.

3.4.2.3. Modeling households risk management strategies

Multivariate probit regression analysis was used to analyze the determinants of households' preference about the relevance of risk management strategies. The dependent variable is households' response about the importance of each risk management strategy to their coffee farm. It was a dummy variable where a risk management strategy takes the value 1 if a household prefers a given risk management strategy is important to his/her own coffee farm/business or otherwise zero.

Behavioral response models involving more than two possible outcomes are either multinomial or multivariate. Multinomial models are appropriate when individuals can choose only one outcome from among the set of mutually exclusive, collectively exhaustive alternatives. However, in this study the risk management strategies are not mutually exclusive; considering the possibility of simultaneous utilization of multiple risk reducing strategies and the potential correlations among these adoption decisions, multivariate probit model was used. In this study, factors influencing households use of risk management strategies were examined in the absence of formal insurance market: as crop and livestock diversity, pest and disease management, non-farm employment, extension advice, and market contracts. Therefore, a multivariate probit model allowing for the possible contemporaneous correlation in the decisions to preferences of the six risk management strategies was specified as follows:

$$Y_{ij} = x'_{ij} \beta_j + \varepsilon_{ij}, \quad (17)$$

Where Y_{ij} ($j=1, \dots, m$) represent households choice about the relevance of risk management strategies (in our case $m = 6$) faced by the i^{th} producer ($i=1, \dots, n$), x'_{ij} is a $1 \times k$ vector of observed variables that affect households responses about the importance of risk management strategies to their coffee farm, β_j is a $k \times 1$ vector of unknown parameters (to be estimated), and ε_{ij} is the unobserved error term. In this specification, each Y_{ij} is a binary variable; and, thus, equation (18) is actually a system of m equations ($m = 6$ in this case) to be estimated:

$$\begin{cases} Y_1^* = \alpha_1 + x'_{ij} \beta_j + \varepsilon_1 \\ Y_2^* = \alpha_2 + x'_{ij} \beta_j + \varepsilon_2 \\ Y_3^* = \alpha_3 + x'_{ij} \beta_j + \varepsilon_3 \\ Y_4^* = \alpha_4 + x'_{ij} \beta_j + \varepsilon_4 \\ Y_5^* = \alpha_5 + x'_{ij} \beta_j + \varepsilon_5 \\ Y_6^* = \alpha_6 + x'_{ij} \beta_j + \varepsilon_6 \end{cases} \quad (18)$$

$$Y_i = \begin{cases} 1 & \text{if } Y_i^* > 0 \\ 0 & \text{if } Y_i^* \leq 0 \end{cases} \quad (19)$$

With $Y_1^*, Y_2^*, Y_3^*, Y_4^*, Y_5^*, Y_6^*$ are a set of six latent variables underlying each of the risk management strategies preferred by households such that $Y_i = 1$ if $y^* > 0$; 0, otherwise. If the vector of random errors ε_{ij} were independently and identically distributed, estimating the unknown parameters of the model would be simple. Socio-economic factors and households' perception to sources of major agricultural risks were used as explanatory variables. One could consistently and efficiently estimate the β_j parameters by a series of 6 independent binary probit. However, as we noted above, it is possible that sample households might prefer the relevance of risk management strategies simultaneously and thus it is likely that these decisions might be correlated. Consequently, the elements of ε_{ij} likely will experience stochastic dependence. Ignoring such dependency in multivariate choice models may lead to biased estimates of the choice probabilities and incorrect

estimates of the standard errors of the parameters (Kiefer, 1982).

Ashford and Sowden (1970) also suggest that the dependence among the elements of ε_{ij} can be considered by assuming that ε_{ij} is multivariate normally (MN) distributed. Because of the MN assumption, this model has been called the multivariate Probit (MVP) model. Hence, in the MVP approach to estimate the unknown parameters in Equation (18), the error terms (across $j = 1, \dots, m$ alternatives) are assumed to have MN distributions with mean vector equal to zero. With the assumption of multivariate normality, the unknown parameters in equation (18) can be estimated using Stata's Multivariate probit command which applies the method of simulated maximum likelihood (SML) that uses the Geweke-Hajivassiliour-Keane (GHK) simulator to evaluate the multivariate normal distribution.

Cappellari and Jenkins (2003) also stated that the simulated probabilities are unbiased and bound within the (0, 1) interval. The variance-covariance matrix V of the cross-equation error terms has values of 1 on the leading diagonal (for reasons of parameter identifiability). Of particular interest are the off-diagonal elements (to be estimated) in the covariance matrix, ρ_{kj} which represents the unobserved correlation between the stochastic component of the k^{th} and the j^{th} risk management strategy. It thus, measures how far the unobserved factors influence use of risk management strategies.

3.4.2.4. Modeling determinants of governance structure choice

The present study intends to explain the effect of internal and external factors (transaction attributes, social capital, institutional environment and socio-economic characteristics) on governance structure choice, and therefore three dependent variables are investigated. As one actor can be involved in one or more than one type of governance structure, it is found appropriate to use a multivariate probit model to analyze the determinants of governance structure in the coffee supply chain in the study areas. Trivariate probit estimates 3-equation probit models, by the method of maximum simulated likelihood (Cappellari and Jenkins, 2003).

The variance-covariance matrix of the cross-equation error terms has values of 1 on the leading diagonal, and the off-diagonal elements are correlations to be estimated ($\rho_{ji} = \rho_{ij}$, and $\rho_{ii} = 1$, for all i

= 1... 3). The Trivariate⁸ probit using GHK simulator evaluates the 3-dimensional normal integrals in the likelihood function. For each observation, a likelihood contribution is calculated for each replication, and the simulated likelihood contribution is the average of the values derived from all the replications. The simulated likelihood function for the sample as a whole is then maximized using standard methods. A detailed description of this model is shown in Greene (2003) and Train (2003). In this model, the choice of governance structure is considered as a system of a multiple choice equation ($i = 1...3; j = 1...n$) respective to each type of governance structures.

$$\text{GovStr}_{ij} = \alpha_{0j} + \beta_{1j} \text{TransAttrb}_{ij} + \beta_{2j} \text{InstEnv}_{ij} + \beta_{3j} \text{Charact}_{ij} + \dots + \beta_{5j} \text{Eff}_{ij} + \varepsilon_{ij} \quad (20)$$

$$PM_j = AS'_j \beta_{AS} + UN'_j \beta_{UN} + TR'_j \beta_{TR} + HH'_j \beta_{hh} + \text{Eff}'_j \beta_{\text{Eff}} + \varepsilon_{SMj}$$

$$BC_j = AS'_j \beta_{AS} + UN'_j \beta_{UN} + TR'_j \beta_{TR} + HH'_j \beta_{hh} + \text{Eff}'_j \beta_{\text{Eff}} + \varepsilon_{BCj}$$

$$CO_j = AS'_j \beta_{AS} + UN'_j \beta_{UN} + TR'_j \beta_{TR} + HH'_j \beta_{hh} + \text{Eff}'_j \beta_{\text{Eff}} + \varepsilon_{COj}$$

Where: GovStr = Governance structure i choice by the coffee grower j, TransAttrb_{ij} = Transaction attribute i of the household j, InstEnv = Institutional environment, HH = household characteristics, AS= Human asset specificity, UN= Uncertainty, TR= Trust, Eff= technical efficiency scores of households, PM_j = Primary market, BC_j= Bilateral Contract, CO_j= Cooperatives, ε_{ij} = Error terms, α_{ij} , and β 's are the coefficients to be estimated.

3.4.3. Model diagnostic tests for econometric analysis

The likelihood ratio statistic (LRS) and Wald test (Wt) are the two procedures, that are mostly used for testing hypotheses about overall model fitness.

To conduct LRS test, both the unrestricted and the restricted models were fitted using the maximum likelihood method (or some equivalent method). The statistic has a limiting chi squared distribution with degrees of freedom equal to the number of restrictions being tested. A common test, which is similar to the F test that all the slopes in a regression are zero, is the LRS tests that all the slope coefficients are equal to zero. In this study both Likelihood ratio tests and Wald tests are used to test

⁸ Trivariate Probit estimates simulated maximum-likelihood three-equation probit models using the GHK smooth recursive simulator. The simulated maximum likelihood technique consists in simulating the multivariate normal integrals which are involved in the likelihood equation. The simulated probabilities are fed into the likelihood function which is then maximized using traditional techniques. See Greene (2000) for a description of the simulation algorithm.

the overall fitness of models such as, Tobit model (for determinants of technical inefficiency), multivariate ordered probit models (for determinants of households perception about sources of risk), Multivariate probit (for determinants about the preferences and relevance of risk management strategies for various risk sources that households perceive), Trivariate probit (for determinants of the choices of governance structures).

To test whether there exists mean or proportional differences among the sample we used F-test and/or chi square tests using one way ANOVA were used. For checking problems of multicollinearity VIF test and for heteroskedasticity, Breusch-Pagan tests were conducted.

3.5. Definition of Variables and Hypotheses

3.5.1. Dependent variables

This study addresses the technical efficiency, risk perceptions and risk management, and governance structure choice variables that were used in both the descriptive statistics and econometric analysis. The identification of these variables was made based on theoretical, conceptual, empirical justifications and characteristics of coffee production and marketing. These variables include both the dependent and independent variables measured in physical and monetary terms.

Technical efficiency measurement and its determinants

Coffee yield is a dependent variable of the production function. It is the physical yield/output of coffee (in whole dried cherries⁹) measured in kg per hectare per year for each sample household. Smallholder coffee growers in the study area produce and mostly sell whole dried cherries and sometimes red cherry to different actors in the coffee supply chain. And hence, ICO recommendations of conversion were used to convert red berries and parchment coffee into whole dried cherry. To determine technical efficiency of coffee production, the natural logarithm of both output (coffee yield in terms of whole dried cherry in kg per hectare) and inputs such as coffee land

9 For coffee Arabica, ICO recommends as a conversion factor 50 kg of clean green beans from 100 kg of whole dried cherries and 80 kg of clean green beans from 100 kg of parchment coffee. ICO also recommends one kg of clean beans from 6 kg of red cherries. See

<http://www.thecoffeeguide.org/coffeeguide/world-coffee-trade/conversions-and-statistics/>

size in ha, labour in man days per ha and organic manure in quintal per ha were used to estimate the production function using stochastic frontier analysis. Using the Cobb-Douglas production function, estimation of TE for individual farms is predicted by obtaining the ratio of the observed production values to the corresponding estimated frontier values. To identify the determinants of technical inefficiencies, Tobit model was used where the inefficiency scores are regressed on selected explanatory variables.

Risk perceptions and risk management strategies

For the risk perception analysis, there are five dependent variables such as households' perception to five sources of major agricultural risks and six risk management strategies. Households perception to sources of major agricultural risks are measures of perceived sources of risks, in which the household head ranks the five major agricultural risks (production, market, financial, legal and human) in terms of importance (5 being the most important perceived source of agricultural risk that highly affect households coffee farm business and 1 being the least perceived source of agricultural risk to a coffee farm business). And hence, the nature of the perceived risk rating variable is of the "ordered" type, and it takes ordered discrete values from 1 to 5. Concerning risk management strategies, there are six dummy dependent variables having a value of 1, if a household head prefers a particular risk management strategy as relevant to his coffee production and/or marketing, 0 otherwise.

Governance structures

Governance structural choices are alternative modes of coffee transaction arrangement choices by smallholder coffee growers described in terms of their patterns of attributes that differ in discrete structural ways among smallholder coffee growers. In this study, governance structure is considered as a system of a multiple choice equation ($i = 1, 2, 3$, or any combinations of $j = 1 \dots n$) respective to each type of governance structures which are spot market, bilateral contract and cooperatives.

Table 2: List of dependent variables and their descriptions

Variable	Description of dependent variables
ln output (Qt)	Total amount of coffee (whole dry cherries) harvested, measured in kg/ha in a year
μ	Inefficiency effects obtained from stochastic frontier analysis
Y*	Perceptions to risk sources (rankings); (1= least important; 2= less important; 3 = somewhat important; 4= more important; 5= most important)
Y*	Relevance of risk management strategy; a dummy variable (1= the particular risk management strategy is relevant and preferred; 0= otherwise)
GSC(Z)	Governance structure choices: spot market (1=yes; 0=otherwise), Bilateral Contract (1=yes; 0 = otherwise), and Cooperatives (1=yes; 0 = otherwise)

Source: Own description

3.5.2. Independent variables for Technical Inefficiency

Sex of a household head: Sex is a dummy variable having a value of 1 if the sex of a household head is male or 0 otherwise. Temesgen and Getachew (2016) found that sex of a household affects TE of coffee production negatively. According to their finding women were more technically efficient than men. However, clearly constraints to agricultural productivity are often gender-based. For example, women farmers generally face more barriers than men in operating effectively in factor markets. As a result, they incur higher costs for information, technology, inputs, and credit and their productivity is lowered. Women also have relatively lower incentives to increase productivity. Thus, if planners are unaware of gender-based differences in agriculture, program outcomes may not be achieved as planned. Female-headed households are expected to face more difficulties in accessing markets and as a result display higher levels of technical inefficiency. Therefore, in this study, it was hypothesized that sex has indeterminate effect on technical inefficiency of coffee production.

Experience in coffee production: Experience is a continuous variable reflecting the farmer's experience in coffee production measured in years. According to Thong *et al.* (2014), coffee farming experience of the household head was a key factor that decreased technical inefficiency in coffee production. Moreover, Hailu (2009) had found a positive relationship between experience and technical efficiency among coffee growers in Ethiopia. Similarly, in this study, experience in coffee production was hypothesized to affect technical inefficiency negatively. Since age was highly correlated with households' experience, it has not been considered in the efficiency model analysis.

Level of education: In this study, household heads level of education is considered as a dummy variable having the value of 1 if the household head is illiterate or 0 otherwise. And it is considered as a proxy variable for managerial ability of the decision making unit (a household head). Access to education with increased experience could guide to a better management of farm or marketing activities. Technical efficiency is commonly associated with the management skills of the farmer (Coelli *et al.*, 1998). The efficient organization of the production process depends on the availability of relevant technical knowledge as well as on the access to productive resources. Hence, the level of households' education was hypothesized to negatively affect technical inefficiency of coffee production positively. Similar to our hypothesis, Thong *et al.* (2014) found a significant and positive relation between households' educational level and technical efficiency of coffee production in Vietnam.

Family size: It represents total number of individuals within a household. It is evident that family members in smallholder farming community are the major sources of labour supply and also primary consumers of the agricultural produces. Thus, it was expected that households with large size have an advantage of harvesting coffee timely particularly during peak production seasons and hence improve their production efficiency. To supplement our hypothesis, Eswaran and Kotwal (1986) indicated that the number of children and adults available for working on the coffee plantation reflect the household's access to family labor, which, if labor markets are imperfect, is expected to have an efficiency-enhancing effect.

Livestock holding: Total livestock holding of the household is measured as a continuous variable in terms of TLU. Farmers who have more livestock are expected to be more efficient in coffee production than those who have no or few livestock. This is because livestock provides manure fertilizer and is a source of income that can be used to purchase the necessary improved agricultural technologies. Therefore, it was hypothesized that TLU has a negative effect on the technical inefficiency of coffee production.

Labour: This represents the aggregate labour in man days (family and hired) used for maintenance of coffee plantation. Labour is a variable used as an input to determine the production function. Labour in man days was hypothesized to increase coffee productivity of households. In agreement with our hypothesis, labor has positive and highly significant effect on coffee production. This is in

accordance with the study of Wollni and Brümmer (2009), and Poudel *et al.* (2011).

Organic Manure: It was measured in quintal per ha applied on coffee production. This is the third input variable used to determine the level of coffee productivity. Cattle manure has potential to be used as an organic nutrient source in coffee production (Chemura *et al.*, 2010a) while recycling coffee wastes such as pulp and pruned branches and stems as direct inputs or in combination with green manures were effective in promoting coffee growth and yield and also economically viable (Chemura *et al.*, 2010b).

Number of coffee plots: Is a continuous variable measured by the total number of coffee plots a household has. The land ownership patterns are characterized by fragmentation where farmers own many plots in different places (Musahara and Huggins, 2005). Coffee production is mostly characterized by cultivation with many sparsely located plots of land. This might affect households' technical efficiency negatively due to high transaction costs and poor management of coffee plots. Thus, in this study, it was hypothesized that higher number of coffee plots affects technical inefficiency of coffee production positively.

Improved coffee variety: In this study, improved coffee variety is considered as a dummy variable having the value of 1 if the household head uses improved coffee variety or 0 otherwise. Due to higher performance levels and suitability for local agro-ecological conditions, the use of coffee varieties might result in higher output levels and hence higher technical efficiency.

Pruning of coffee: This is a dummy variable having the value of 1 if the household has pruned coffee within the last 3 years and 6 months before data collection and 0, otherwise. Coffee pruning is a vital agricultural practice that rejuvenates the plant through the removal of unproductive wood and through the promotion of new suckers which will develop into new stems. It is one of the most critical factors for good coffee production. Its contribution to total yield has been rated at about 30 percent (Ibero, 2005). Moreover, Kadir *et al.* (2004) cited in Saragih (2013) indicated that coffee pruning would give a role in improving growth of coffee plant (amount of productive branch, number of coffee flower). Thus, pruning practice in this study was expected to affect coffee growers' production inefficiency negatively.

Mulching: In this study, mulching is considered as a dummy variable having a value of 1 of a

household has used mulching practice in the last 3 years and 0 otherwise. Mulching enhances soil moisture status through improved infiltration and reduction in evaporation. According to agronomists, there is direct relationship between mulching and better yields. Henry and Emmanuel (2016) argued that pineapple farmers in Ghana who adopt the use of plastic mulch are technically more efficient in production than those who do not. Similarly, in this study, it was expected that mulching has negative relations with technical inefficiency of coffee production.

Intercropping: Intercropping is considered as a dummy variable having a value of 1 if a household applies intercropping of coffee with other crops and 0, otherwise. There are reports of coffee agro forestry systems with higher net income than coffee monocrop (Souza *et al.*, 2012), and a trend to higher technical efficiency (Kilian *et al.*, 2006), when considering other products besides coffee production. Similarly, Alene *et al.* (2006) argued that farmers can achieve high levels of technical efficiency through intercropping. However, Nginyangi (2011) found that intercropping coffee with other crops was shown to have a significant negative influence on economic efficiency. Moreover, the time, the energy and the efforts that the smallholder coffee growers exert in case of coffee monocrop might be greater than that of coffee intercropping with other crops. However, in contrast to the result of Nginyangi (2011), in this study, it was hypothesized that intercropping has indeterminate effect on technical inefficiency of coffee production.

Oxen: Is a continuous variable that is measured in terms of the number of oxen a household have. In this study, it is expected that households with more number of oxen can effectively produce coffee using oxen. Thus, in this study it was hypothesized that the numbers of oxen has a negative effect on the level of technical inefficiency in coffee production. Similar to our expectation, Temesgen and Getachew (2016) found a positive association between the number of oxen and production efficiency of coffee in East Wollega Zone.

Credit utilization level: This refers to the amount of credit received and utilized for coffee production in a year by a household due to shortage of fund in coffee production or marketing. It was hypothesized that the amount of financial credit obtained is one of the key factors that can increase technical efficiency in coffee production. For instance, in supporting our hypothesis Mukasa *et al.* (2017) investigated the nature, extent, and impacts of credit constraints in Ethiopia's agriculture and they pointed out that, alleviating credit constraint would generate substantial productivity gains, in

Ethiopia, of around 60 percent. Moreover, in agreement with our hypothesis, Amadou (2007) and Thong *et al.* (2014) had found significant and positive relationship between access to credit and technical efficiency of coffee production.

Frequency of contact with extension workers per year: It is a continuous variable expressed by the number of visits in a year to the coffee farm by extension agents. Extension service is the major means through which new ideas and techniques are transmitted to farmers. This study attempted to determine the role played by extension services in enhancing technical efficiency of coffee production among smallholder coffee growers. Extension agents provide information on the availabilities of improved agricultural technologies and dictate how to adopt recommended agronomic practices in coffee production. So smallholder coffee growers' who have more contact with extension worker can improve their decision to adopt agricultural technologies in coffee farming and hence improve their level of technical efficiency. A negative relationship was, therefore, expected between the frequency of extension contacts and technical inefficiency effects.

Distance to coffee plots: Is a continuous variable which refers to the average distance traveled to the farthest coffee plot, measured in kilometers. In most areas poor road infrastructure and long distance may hinder close supervision and frequent communication with actors along agricultural supply chains. The closer they are to the plots, the more likely that the coffee grower will take care of their coffee plants frequently. Temesgen and Getachew (2016) found positive and statistically significant relations between production efficiency and distance to coffee plots in Eastern Wollega. Therefore, in this study it is hypothesized that distance from the average coffee plot has indeterminate effect on the technical inefficiency of coffee production.

Membership in a cooperative or union: This variable represents coffee growers' participation in a coffee farmers association or union. This is a dummy variable having a value of 1 if the household head is the member of coffee growers cooperative or union and 0 otherwise. The involvement of coffee growers in a cooperative or union has mostly a positive impact in increasing the bargaining power of coffee farmers, give them price incentive and provide market storage. Moreover, it motivates farmers to organize themselves as a group for sustainable production and income generation which in turn improves their level of technical efficiency (Amadou, 2007; Onumah *et al.*, 2010). Similarly, in this study it is hypothesized that membership in a cooperative or union has a

negative effect on technical inefficiency of smallholder coffee growers.

Ownership of mobile phone: It is indicated as a dummy variable having a value of 1 if a household head has a mobile phone and 0 otherwise. Sources of information are important for facilitating marketing activities of supply chain actors and in turn might induce the technical efficiency of coffee growers. Ownership of mobile phone by the household head is a proxy variable that is used to measure market information access. In view of this, household head that has mobile phone had better market related information access than others and hence enhances the technical efficiency of coffee production. Accordingly, a negative relationship was expected between the ownership of mobile phone and technical inefficiency of coffee production.

Independent variables for perceptions to sources of risk and risk management strategies

Age of a household head: is measured as respondent's age in years, at the time of data collection. As the age of household head increases, his/her physical strength tends to decline and this affects their perceptions to sources of risk, particularly, the human related risks. Regarding the relationship between age and risk perception, it is commonly assumed that older people are more cautious and risk averse than their younger counterparts, however, the research findings on age differences in risk taking is mixed. While some research has found that older adults are less risk seeking, other research has found the opposite or no differences. Similar to this hypothesis, in the risk perception models for conventionally grown produce, Williams and Hammitt (2001) found that age was positively associated with higher perceived agricultural risks. One explanation is that age differences vary across risk domains (Bonem *et al.*, 2015). Therefore, in this study, it was assumed that as the age of a household head and households' perception about sources of agricultural risks is mixed.

Sex of a household head: Williams and Hammitt (2001) argued gender as a significant predictor of perceived risks, with women having higher perceived risks than men. This is mainly because women mostly are very sensitive to risks than men. However, concerning households' perception to sources of risk, in many literatures sex has mixed effects. Similarly, due to traditional, cultural and bounded rationality, it was hypothesized that sex and households' perception to sources of risks are indeterminate.

Level of Education: is considered as a dummy variable having the value of 1 if the household head

is illiterate or 0 otherwise. Mustafa (2006) argued that more educated farmers perform better in managing agricultural risks than the counter parts. Similarly, Agira *et al.* (2005) found that education has positive relationship with risk management strategies. Educational level is expected to be positively related to risk management strategies such as ‘diversification’, ‘pest and disease management’ and ‘non-farm employment’ and information retrieval and use. Thus, in this study, it was expected that the level of education determines household’s perception of risk sources, use and preference of risk management strategies positively.

Coffee land size: Land size is the total area of land measured in terms of hectares allocated for coffee production by the i^{th} coffee growing household. It was expected to determine household’s perception to different sources of risk. Agira *et al.* (2015) found that farmers who have allocated higher areas of land to growing strawberries were more likely to perceive risk sources significantly than farmers who have allocated smaller land sizes. Similarly, in this study it was hypothesized that coffee land size determines households’ perception to sources of risks and risk management responses positively.

Moreover, in order to better understand whether there is a relationship between households perceptions to sources of risk and/or risk management strategies, this study incorporated households characteristics including farm location, experience, frequency of extension visit, access to credit, social capital, TLU, mobile ownership, household size, etc. Some studies that discuss perceptions about climate change and climate related information suggest that perceptions remain constant among coffee producers in Mexico, but at the same time that “social identity influences perceived credibility and legitimacy of information” (Frank *et al.*, 2011). Agira *et al.* (2015) found that farming experience has significant relationship with risk management strategy.

Additionally, Finucane and Holup (2006) found mixed opinions on the degree to which socio-demographic characteristics influence particular risk perceptions. Moreover, Velandia *et al.* (2009) found that proportion of owned acres; education, and age are some of the factors that significantly affect the adoption of the risk management tools. Similarly, this study collected data on households characteristics to either find notable differences in perceptions between different demographic groups or locations to document whether farmers generally do have similar risk perceptions and risk management strategies over household characteristics.

Coffee management practices: In this study, pruning and use of improved varieties are included as

dummy variables as proxy to coffee management practices that can affect households' perception about production risks. Pruning is a dummy variable having the value of 1 if the household has pruned coffee within the last 3 years and 6 months before data collection and 0, otherwise. Improved coffee variety is also considered as a dummy variable having the value of 1 if the household head uses improved coffee variety or 0 otherwise. Farm management practices could also indicate different levels of perceived risk or perceived ability to adapt. For example, Hagggar *et al.* (2011) suggested that coffee yields can be stabilized under coffee management practices over time avoiding the “boom and bust” yields of sun coffee plantations in Costa Rica and Nicaragua. Similarly, in this study, it was hypothesized that households who use pruning and new varieties of coffee are less likely to perceive production risks as an important source of risk than the counterparts.

Biophysical and weather factors: This study explores households' awareness level about biophysical factors such as variability in precipitation, infestation of pests, frost attack, and incidence of disease. How these areas intersect to influence households' perceptions to sources of risks is a pressing question for smallholder farmers and the industry as a whole (Rivera *et al.*, 2015). These same drivers are also of concern in the coffee sector. This study offers the opportunity to obtain an initial understanding of smallholder coffee producers' awareness about biophysical factors on sources of risks among smallholder coffee growers. Thus, it was hypothesized that households' who are conscious about the effects of biophysical factors more likely tend to perceive production risks as the most important source of risk to their coffee production.

Perception of sources of risk and risk management strategies: The price and yield risks, along with a farmer's attitude toward risk, have a major impact on the choice of risk management strategies and tools (Hardaker *et al.*, 2004). Niguyen *et al.* (2007) found that farmers who had greater exposure to risk appear to understand the risks they face and are well prepared to manage them. Additionally, Velandia *et al.* (2009) indicated that levels of business risks are some of the factors that significantly affect the adoption of the risk management tools.

In addition to what is mentioned above, it is at least equally important to answer the question of how farmers perceive the importance of risk factors surrounding their activities, as it strongly influences the shaping of their risk management strategies. Therefore, this study assumes that households' perceptions to sources of risk could determine households' responses and preferences of risk

management strategies in the context of risk perception about production, market, financial, institutional and human related risks. In supporting our hypothesis, Bagheri and Shabanali (2016) found significant relationships between potato growers' risk perceptions and the application of risk management strategies in Iran. Thus, similarly, in this study, it was hypothesized that households with higher perceptions about sources of risk more likely prefer risk management strategies than their counterparts.

Availability of price information and volatility of coffee price: Local markets mostly are the main places to exchange agricultural produces, share information regarding price and other market attributes. Access to reliable, timely and relevant information can help significantly and in many ways to reduce farmers' risk and uncertainty, empowering them to make good decisions. Information has an extensive and multifaceted role in agriculture. It empowers farmers to respond to different types of risk, market incentives and competition more efficiently (Mittal and Mehar, 2013). Similarly, in this study, it was hypothesized that households who obtain price information at primary markets and/or recognize high coffee price volatility compared to prices of cereals are more likely to perceive market, financial and institutional risks as an important source of risks.

Independent variables for governance structure choices

Human asset specificity: is a term related to the inter-party relationships of a transaction. It is usually defined as the extent to which the investments made to support for creating strong relationships during a particular transaction. Human asset specificity refers to relation-specific "know-how" developed between actors involved in the transaction. As defined by Heide and John (1992), human asset specificity addresses areas such as empirical knowledge specific to a particular supplier's product, or it is the time and effort that goes into learning about a supplier's specific requirements (Artz and Brush, 2000). In this study, human asset specificity is considered as an index variable measured using different constructs: such as membership in a coffee farmers' association, investment on education, and the experience cumulated across the year in coffee farming. In this study, it was hypothesized that the probability of choosing a bilateral contract and/or cooperative types of governance structure is significantly and positively influenced by the human asset specificity. When the specificity of the asset is high, the risk for actors to be facing a hold-up (non-transferability) problem is great.

Uncertainty: When transactions are conducted under uncertainty, it can become very costly or impossible to anticipate all contingencies (Frank and Henderson, 1992). The theory states that uncertainty causes firm leaders to rely more on nonmarket coordination methods. Also, the greater the uncertainty of prices in the market, the more the actors restrict their range of possible exchange partners to those with whom they have had prior interactions and have transacted in the past (March, 1988). It is therefore important to determine the types of transaction uncertainty that affect the choice of governance structures.

As stated by Ruben *et al.* (2007), the more uncertain the environment of the supply chain, the more “central” governance is needed to guarantee that the outlet selection objectives of all stakeholders are attained. High uncertainty may discourage a supplier from making specialized asset investments if appropriate safeguards are absent (Lu, 2007). In this study, uncertainty is considered as an index variable measured by households’ information about the stability of the price, the quality and quantity of coffees delivered to buyers over time. The coffee producers may be part of a governance structure for producing specific labeled products (dry coffee and/or berry) for markets that require specific investments, and at the same time maintain other production, not included in the agreements, to which they can switch. When they have this capacity to reduce uncertainties associated with, they adopt a mode of governance close to market arrangements (Sauvee, 2002). Hence, the higher the uncertainty with respect to price, quality and quantity, the governance structure is expected to be more of bilateral contract and cooperatives types of governance structure.

Connectedness: In this study, the transaction connectedness is an index variable measured using the following constructs: awareness of the household about the quality required by the customers or their buyers and the awareness of the price paid by them, and the connectedness of the harvesting period to the demands of traders and consumers’ demand. It was assumed that the higher the degree of transaction connectedness, the more likely the actor is involved in more integrated governance structures. Transactions differ in how they are connected to other transactions, especially those involving investments which are highly specific. It is possible that the assets or service they yield are strongly complementary. Some transactions are largely dependent on others giving rise to hold-up problem and locked-in effects (Slangen *et al.*, 2008).

For understanding the behavior of any single supplier within a supply chain, the two critical

characteristics of ties in a supply chain are the supplier's dependence on the dominant buyer and the connectedness to the other network of suppliers (Cook, 1977). When the supplier's dependence on the buyer is high, it results in high cooperation (Provan, 1993). Also when transactions involve a high degree of connectedness to other transactions, or are executed in small batches, or occur over short periods of time, there were increasing coordination costs (Wood, 2003). When the transactions have a strong connection, a strong coordination mechanism is favorable. The need for such mechanisms influences the transaction costs (Meyer *et al.*, 1992). The stronger the ties between the buyer-seller, the higher the transaction connectedness were (Wong and Chan, 1999). Thus, in this study transaction connectedness is hypothesized that the higher the connectedness of transactions, more likely that households' prefer bilateral contract and cooperative types of governance structures.

Perceived coffee quality: This variable is an index variable measured three indicators such as timely harvest, uniformity of ripeness in a lot, and/or training received on coffee production and quality enhancing practices. It was expected that perceived quality of coffee determine household's choice of governance structures. Perceived coffee quality is expected to determine the primary market governance structure negatively because smallholder coffee growers who produce high quality coffee are less likely expected to transact at the primary markets but more likely in the bilateral contract and/or cooperative governance structures.

Trust : Generally, trust is the belief that other people can be relied on. Is a dummy variable that is used as proxy to social capital. It was hypothesized that trust negatively influence primary market choices and positively to bilateral contracts and cooperative type of governance structures. This is because special relations between actors in primary market transactions are not mainly required as the deal is mainly conducted by hand shaking.

Coffee to total land ratio: is a continuous variable measured by dividing land under coffee to total land holding in hectares. It is a proxy for farmer's economic status and was expected to positively associated with the probability of choosing cooperatives and bilateral contract types of governance structures and negatively with primary market type of governance structure. That means, the larger the coffee to total land ratio, more likely that households prefer cooperative and bilateral contract types of governance structures.

Family size: Is a continuous variable measured by the total number of members in a household. In

this study, it was expected that family size and cooperative type of governance structure are positively related. However, it was expected that family size and spot/primary market and bilateral contract types of governance structures are negatively related.

Technical Efficiency scores: Is a continuous variable that is obtained from the stochastic production function. In this study, it was expected that the higher the level of technical efficiency of a household, more likely they choose cooperatives type of governance structure. But, these households are less likely to choose spot/primary market and bilateral contract types of governance structures.

Location: Two dummies representing the two woredas (namely Chena and Decha) are included in the technical efficiency, perceptions to sources of risk and governance structure models to account for heterogeneity in the sample, due to geographical disparity.

Table 3. Description, measurement and expected sign of explanatory variables on technical inefficiency

Explanatory Variables	Description of variables and measurement	Expected sign on dependent Variables
		Technical Inefficiency
Sex	Sex of a HH head (1 Male; 0= otherwise)	-/+
Family size	The total number of members in a household (persons)(continuous)	+/-
Education	Educational level of a HH head (1 literate; 0= otherwise)	-
Cooperative membership	Membership in a cooperative or union (1= yes; 0 = not)	-
Pruning	A HH pruned his coffee trees in the last 3 years(1= yes ; 0 = not)	-
Improved variety	A HH head uses new varieties of coffee (1= yes; 0 = not)	-
Average age of coffee tree	The average age of coffee tree in years (continuous)	+
Mulching	A HH head uses mulching for his coffee farms (1= yes; 0 = not)	-
Intercropping	A HH grows coffee mixing with other crops with (1=yes; 0 = not)	-
Oxen	The number of oxen a HH has (continuous)	-
Training	No. of times a HH head took training on coffee production (continuous)	-
Experience	Years of coffee cultivating experiences (continuous)	-
Coffee plot	Total number of coffee plots a HH has (continuous)	+
Credit utilization	Credit utilization (1= yes; 0 = not)	-
Mobile ownership	Mobile ownership (1= yes; 0 = not)	-
Distance	The number of Kms traveled to the farthest coffee plot (continuous)	+
Extension visit	The frequency of extension visit a HH received last year (continuous)	-
Chena	HH head is located at Chena woreda (1= yes, 0= otherwise)	+
Decha	HH head is located at Decha woreda (1= yes, 0= otherwise)	-

Table 4. Description, measurement and expected sign of independent variables on perceptions to sources of risk

Explanatory Variables	Description of variables and measurement	Expected sign on dependent Variables				
		Sources of risk				
		Production	Market	Financial	Legal	Human
Sex	The sex of a HH head (1= male; 0 = female)	+/-	+/-	+/-	+/-	+/-
Age	HH heads age in years (continuous)	+	+/-	+	+	+
Family size	The total number of members in a household (persons)(continuous)		+	+	+	+
Education	Educational level of a HH head (1=literate; 0= otherwise)	+	+	+	+	+
Cooperative membership	Membership in a cooperative or union (1= yes; 0 not)	+	+	+/-	+/-	+/-
Pruning	A HH prunes his coffee trees in the last 3 years (1= yes; 0 = not)	+				
Price information	A HH head gets price information at primary markets (1= yes; 0 = not)		+	+/-	+	+/-
Price before 5	The current coffee price is volatile than prices before 5 years (1= yes; 0 = not)		+	+	+	+/-
Price after 5	The current coffee price is less volatile than prices after 5 years (1= yes; 0 = not)		+	+	+	+/-
Price volatility	Perception about coffee price volatility compared to prices of other crops(1= yes; 0 = not)		+	+	+	+/-
Follow ECX price	A HH head gets ECX price information before s/he sales (1= yes; 0= otherwise)		+	+	+	+/-
Government agent	Presence of gov't agent at primary market (1=yes; 0= not)		+/-	-	-	-/+
Improved variety	A HH head uses new varieties of coffee (1= yes; 0= not)	-/+				
Training	No. of times a HH head took training on coffee production and quality maintenance (continuous)	+	+	+	+	+/-
Extension visit	The number of times an extension agent visits a coffee farm last year (continuous)	+/-	+/-	+	+	+/-

Table 4: **Continued**

Coffee plot	Total number of coffee plots a HH has (continuous)	+	+	+	+	+
Credit utilization	Credit utilization by a HH to coffee production and/ or marketing (1= yes; 0= not)	-/+	+/-	+	+/-	-/+
Mobile ownership	Mobile ownership (1= yes; 0 = not)	+	+	+	+/-	+/-
TLU	Total number of livestock holding (continuous)	+	+	-	-	-
Perceived precipitation	HH's perception that the distribution of annual rain is low (1=yes; 0= otherwise)	+				
Frost incidence	Perception that coffee production is affected by frost (1=yes; 0= otherwise)	+				
Disease & pest infestation	Perception that coffee production is affected by coffee diseases and pests (1=yes; 0 = otherwise)	+				
Wild animal attack	Perception that coffee production is affected by animals such as ape, monkey and others (1=yes; 0=otherwise)	+				
Plot distance	The number of Kms traveled to the farthest coffee plot (continuous)	+				
Log coffee income	The log of last year's annual HH income from coffee sale (continuous)	+	+	-	+/-	-
Coffee plot size	Land under coffee tree in hectares (continuous)	+				
Efficiency score	HHs technical efficiency score obtained from stochastic frontier(continuous)	+	+/-	+/-	+/-	-
Chena	HH head is located at Chena woreda (1= yes, 0= otherwise)	+	+/-	+/-	+/-	+/-
Decha	HH head is located at Decha woreda (1= yes, 0= otherwise)	+	+/-	+/-	+/-	+/-

Table 5. Description, measurement and expected sign of independent variables on choices of risk management strategies

Explanatory Variables	Description of variables and measurement	Expected sign on dependent Variables						
		Risk management strategies						
		Pest & Disease mgmt	Crop & Livestock diversity	Retrieval use information	& of contracts	Market contracts	Non-farm employment	Contract farming
Production risk	HHs perception about production risk (5= most important; 1= least important)	+	+	+/-		+/-	+/-	+
Market risk	HHs perception about market risk (5= most important; 1= least important)	-/+	+/-	+		+	+	+
Financial risk	HHs perception about financial risks (5= most important; 1= least important)	+/-	+	+/-		+	+	+
Human related risk	HHs perception about human related risks ((5= most important; 1= least important)	+	+	+/-		+/-	+/-	+/-
Education level	Educational level of a HH head (1= literate; 0 = otherwise)	+	+	+		+	+	+
Family size	The number of members of the household (continuous)	+	+	+		+	+	+
Cooperative membership	Membership in a cooperative or union (1= yes; 0 not)	+	+	+		+	+	+
TLU	Total number of livestock holding (continuous)	-	-	-		+/-	-	+/-
Training	Frequency of training received per year by a HH head on coffee production and quality maintenance (continuous)	+	+	+		+	+	+
Credit utilization	Credit utilization for coffee production (1= yes; 0 = not)	-	+	+		+	+	+
Mobile ownership	Mobile ownership (1= yes; 0 = not)	+	+	+		+	+	+
Improved variety	Use of improved coffee variety (1= yes; 0 not)	+	+	+/-		+	+	+
Coffee plot size	Land under coffee tree in hectares (continuous)	+	+	+		-/+	+	+

Table 6. Description, measurement and expected sign of independent variables on governance structure choices

Explanatory Variables	Description of variables and measurement	Expected sign on dependent variables		
		Governance structural choices		
		Primary markets	Bilateral contracts	Cooperatives
HH size	The total number of members of the household (continuous)	+	+/-	+/-
Education	Educational level of a HH head (1 literate; 0 otherwise)	+/-	+/-	+
Land ratio	Land under coffee divided by total land holding (continuous)	-	+	+
Log income	The log of last year's annual HH income from coffee sale (continuous)	-	+	+
Human asset specificity	Is a variable constructed from factors such as (cooperative membership, educational level and years of experience in coffee production)(Index)	-	+	+
Connectedness	Is an index variable constructed from HHs' awareness about quality required by the customers and the awareness of the price paid by them(Index)	-	+	+
Uncertainty	Is an index variable constructed from (uncertainty about stability of coffee prices, quantity and quality delivered to buyers) (Index)	-	+	+
Communication	HH head communicates with other buyers about prices before sale (1=yes; 0= not)	+	-	-
Trust	HH head trusts coffee buyers(1= yes; 0 = not)	-	+	+
Training	No. of times a HH head took training on coffee production and quality maintenance (continuous)	-	+	+
Perceived coffee quality	Is an index variable constructed using (timely harvest, uniformity of ripeness in a lot, and/or training received on coffee quality enhancing practices)(Index)	-	+	+
Efficiency	HHs technical efficiency score obtained from stochastic frontier	-	+	+
Chena	HH head is located at Chena woreda (1= yes, 0= otherwise)	+	-	-
Decha	HH head is located at Decha woreda (1= yes, 0= otherwise)	-	+	+

4. RESULTS AND DISCUSSION

This chapter deals with the descriptive statistics and econometric model estimation results. Firstly, the descriptive statistics results are presented and discussed. Secondly, econometric results obtained from the stochastic frontier, Tobit (for the determinants of technical inefficiency), Multivariate ordered probit (for determinants of households perception about sources of risks), multivariate probit (for determinants households use and preference about risk management responses), and trivariate probit models (for determinants of households choices about governance structures) are discussed.

4.1. Descriptive Analysis Results

4.1.1. Household characteristics

This sub-section presents descriptive statistical results of demographic and socio-economic characteristics of the interviewed households. Overall, the sample comprised of more males than females. Out of the total number of 337 respondents, 286 (85 percent) of the sample households are male-headed. The average family size is six. The average age of a coffee farming sample household head is 45 years with a slight variation among sample woredas. Education levels of sample households are low. About 49.7 percent of the sample households do not have any formal education, while 42.8 percent have had an education level of primary school. The remaining 6.5 percent of the interviewed farmers have had an education level of secondary school. Households with some secondary education are found in coffee farming due to own interest or the need to undertake coffee farming. There is no any smallholder farmer who have attended technical schools and above.

Concerning gender difference in terms of the level of education, of the sampled 51 women households, the majority 44 (86 percent) do not have any formal education, 6 (12 percent) and 2 (3 percent) have attended primary and secondary levels of education, respectively. On the other hand, of the 286 male headed sample households, 127 (44.4 percent) do not have any formal education, 138 (48.3 percent) and 21 (7.3 percent) have primary and secondary level education respectively. Thus, in terms of educational background, there exist low levels of education amongst female-headed households than male-headed households.

Regarding the marital status, as depicted in Table 7, the majorities (90 percent) of the sample households are married and the remaining 5, 3 and 2 percents are single, widowed and divorced

respectively. As regards to religion, the majority (81.9 percent) follows Orthodox Christianity and 5.9, 5.7, and 6.5 percents constitute Muslim, Protestant and Catholic religions, respectively. With regards to participation in group organizations, about 67 percent of the interviewed households are cooperative members, and the remaining 33 percent are non-members.

Table 7. Descriptive statistics of selected demographic and socio-economic variables by woreda

Variables	Unit	Sample Woredas			Total (N=337)
		Chena (N= 117)	Decha (N= 89)	Gimbo (N= 131)	
HH Characteristics:					
Age	year	46.86	39.36	47.5	45.12
Family size	number	6.65	6.38	5.89	6.28
Head of households are Female	Share (%)	5.93	3.56	5.64	15.13
Head of households are male	Share (%)	28.78	22.85	33.23	84.87
Education:					
Illiterate		18.99	13.24	17.51	49.74
Primary education	Share (%)	12.95	10.09	18.69	43.73
Secondary education		1.78	2.08	2.67	6.53
Marital status:					
Married		32.05	23.15	35.01	90.21
Single	Share (%)	1.78	2.37	0.59	4.75
Divorced		0.59	0.3	1.19	2.08
Widowed		0.3	0.59	2.08	2.97
Religion:					
Orthodox		27.89	23.15	30.86	81.9
Muslim	Share (%)	0	1.19	4.75	5.93
Protestant		2.37	0.59	2.67	5.64
Catholic		4.45	1.48	0.59	6.53
Cooperative membership:					
Yes	Share in (%)	13.65	20.18	32.94	66.77
No		21.07	6.23	5.93	33.23

Source: Own computation results based on survey data, 2015

4.1.2. Land holding and location of sample households

Land holding of a household is a pertinent variable in any agricultural activities. Land tenure over agricultural land are fundamental to the lives of rural population especially in less developed

countries where the majority of the population lives in rural areas and the main sources of income and livelihood are derived from land. In the study areas, non-farm income-earning opportunities are very limited; as a result access to land determines not only households' level of living and livelihood, but also to their food security status.

As depicted in Table 8, sample households own on average 2.37 hectares of land. On average, of the total hectares of land owned by a household, 53 percent (1.22 ha) is used for coffee production. The relative share of land dedicated to coffee reflects the importance of growing coffee to satisfy basic and other subsistence needs. With respect to location, households live on average 2.8 kms away from the nearest market, 1.24 kms away from the farthest coffee production plot, and 3 kms away from the nearest DA office in the kebele.

Comparison of average land holding for the three Woredas was carried out using an F-test and results show that significant differences exist among all the variables such as total land owned, coffee land size, and coffee land to total land ratio, across the study Woredas. This indicates that land holding varies across the study Woredas. Moreover, the mean distance to primary markets, to coffee plots and to the nearest DA office significantly vary between the study woredas at 1, 10 and 5 percent level of significance, respectively.

Table 8. Land holding, average age of coffee trees and location of sample households

Variables	unit	Total	Sample woredas			X ² / F-test
			Chena	Decha	Gimbo	
Total land owned	ha	2.37	3.05	2.4	1.75	15.7***
Cultivated coffee area	ha	1.22	1.1	1.78	0.95	14.4***
Coffee land/total land ratio	In %	53.48	36.1	74.17	54.29	9.36***
Distance to primary coffee market	km	2.8	3.6	3.2	1.8	20.85***
Distance to coffee production plot	km	1.24	1.96	1.05	0.71	2.79**
Distance to nearest DA office	km	3.14	4.15	2.63	2.63	3.21*

Source: Own computation results based on survey data, 2015

4.1.3. Livestock holding of the sample households

Sample households in the study areas own livestock including cows, oxen, small ruminants (goats, sheep), poultry, and pack animals such as donkeys and horses. Concerning the livestock holding of a household, on average they own 2.2 oxen, 2.7 cows, and 4.5 shoats. Regarding the pack animals, on

average a household has 0.23 horses, 0.21 donkeys and 0.16 mules. On average, each household has a total of 4 TLU¹⁰. Moreover, the F-test result indicates that there exists a significant statistical difference for all livestock holdings and pack animals between the study woredas.

Table 9. Descriptive statistics about livestock holding of sample households (number)

Variables	Total		sample woredas			F-test
	Mean	Std. Dev.	Chena	Decha	Gimbo	
TLU	4	2.18	4.59	3.81	3.59	7.15***
Cow	2.74	1.83	3.23	2.85	2.23	10.04***
Oxen	2.23	1.15	2.43	1.81	2.33	8.56***
Shoat	4.5	4.75	5.49	4.97	3.30	7.42***
Horse	0.23	0.49	0.26	0.40	0.07	14***
Donkey	0.21	0.43	0.11	0.06	0.39	22.46***
Mule	0.16	0.38	0.09	0.47	0.02	53.95***
Hen	6.6	4.65	7.64	4.71	6.95	11.32***

Source: Own computation result based on survey data, 2015

4.1.4. Crop and livestock income of households

As presented in Table 10, on average, crop and livestock incomes of a household for the year 2014/15 constitute about 22% (4285 birr) and 17% (3286 birr) of the average total agricultural income. Compared to an overall agricultural income of 19, 439 Birr, more than 62.7 percent of the total agricultural income (excluding the value of own-consumption) of the sample households comes from coffee. Average annual coffee income of the sample households in the year 2014/15 amounted to 12,185 Birr.

Thus, it can be said that, in the study areas, coffee production is a prime source of their livelihood income. As shown in the same table, livestock income represents 17 percent of the total agricultural income. Thus, it can be said that livestock is also a potential source of livelihood in the study areas next to coffee and other crop income. However, as shown in Table 10, the F-test statistic indicates that there is no significant difference in livestock income between the study woredas. But, there exists a statistically significant difference in coffee income, other crop income and total agricultural income between the study woredas.

10 Following FAO measurement TLU-Tropical Livestock Unit is measured as: 1* No. of Camels + 0.7 * No. of cows + 0.7 * No. of oxen + 0.1 * No. of shoats (sheep + goats) + 0.8* No. of Horses + 0.7* No. of mules + 0.5* No. Asses + 0.01 * No. of chicken + 0.2* No. of pigs.

Table 10. Average crop and livestock income of the sample households in Birr

Variables	Total	Sample Woredas			F-test
		Chena	Decha	Gimbo	
Livestock income	3286.40	2789.9	2732.7	3286.4	0.71
Total agricultural income	19438.5	14286.7	22059.4	22259.8	17.75***
Coffee income	12185.4	7832.9	16893.4	12874	37.66***
Other crop income (Excluding coffee)	4285.70	3663.9	2433.3	6099.4	14.15***

Source: Own computation results based on survey data, 2015

4.1.5. Purposes of growing coffee

Sample households in the study areas grow a diverse range of food crops such as teff, beans, inset, wheat, maize, sorghum, barley, red pepper, etc. and fruits such as lemons, banana and export products such as coffee, tea, spices, *khat*, etc. In addition to the livestock they own, these cash crops are undertaken to sustain their living expenses and supplement their income.

Coffee income is treated as unique by sample households since it is generated in a short period due to the seasonal aspect in coffee harvesting and can be obtained as a lump sum. As also indicated during focus group discussion and key informant interview, for a coffee grower, it is with the money obtained from coffee sale that they fulfill many of their own basic needs.

The sampled households during an interview expressed the main purposes for growing coffee. Among the given reasons are that coffee growing has become part of their culture, due to the compulsory nature of its cultivation inherited from their ancestors. Thus, one can say that smallholder coffee growers have been cultivating coffee for the reason that their fathers and grand-fathers had been cultivating coffee for many years. In addition to this, coffee is found to be the most important source of income in those geographical areas where it is suitable. Sample households' responses about the main purposes why they are engaged in coffee cultivations is shown in Table 11.

Table 11. Sample households' reason for growing coffee in the study areas

Reasons of growing coffee	Freq.	Percent	Cum.
Environmental protection	48	14.24	14.24
Just a tradition	19	5.64	19.88
Earning money and consumption	249	73.89	93.77
Combination of all the above reasons	21	6.23	100
Total	337	100	

Source: Own computation results based on survey data, 2015

The majority 249 (74%) of the sample households responded that they grow coffee for earning income and consumption purposes. Of all the households interviewed, 48 (14.24%) said the main reason for growing coffee is for environmental protection, while 19(5.6%) of the households indicated that upholding the tradition of their forefathers is the main reason for growing coffee. Only 6 percent of these households indicated that they grow coffee to meet multiple objectives such as environmental protection, tradition, earning income, and for home consumption purposes.

4.1.6. Improved coffee management practices

Smallholder coffee growers who apply modern inputs and who manage coffee trees well are more likely expected to attain more production of coffee. Concerning the use of modern inputs, as indicated in Table 12, more than half (58.75 %) of the sample households were using improved varieties of coffee. However, the use of chemical inputs such as fertilizers, herbicides and fungicides in coffee production is nonexistent in the study areas. During the focus group discussion, the discussants further indicated that the low or non-use of modern inputs has been motivated by a deliberate government policy that discourages use of fertilizers or chemicals in the coffee sector, especially by smallholders. This was further confirmed by government officials at woreda and zonal levels that smallholder coffee growers were told to keep to produce organic coffee as the country thrives to gain reputation in this brand. The practice of mulching and pruning also became much more prevalent in enhancing smallholder farmers' coffee productivity. On average, over the last three years, about 44.5, 55.79 and 58.75 percents of sample households did practice intercropping of coffee with other agricultural crops, mulching and pruning, respectively. There is significant difference in coffee management practices such as pruning, intercropping, mulching and use of improved variety between the study woredas.

Regarding the type of coffee processing, 81 percent of the sample households apply dry processing methods while only less than a percent use wet processing and about 17 percent of these households use both wet and dry processing techniques. Concerning the type of coffee harvesting, the majority (62%) responded that they use selective harvesting or picking of coffee berries. The remaining 21.7 and 16.6 percents of the surveyed households indicated that they use strip harvesting and both methods (strip and selective harvesting) respectively. This indicates that still a significant number of coffee growers use strip harvesting and hence it could have a significant effect on the quality of

coffee.

Table 12. Improved coffee management practices and modern inputs use

Variables	Total		Woredas			χ^2
	Freq.	Percent	Chena	Decha	Gimbo	
Intercropping	187	55.49	47.01	73.03	51.15	8.05***
Mulching	198	58.75	53	58.8	64.07	1.11
Pruning	216	64.1	49.6	60.7	79.4	13.09***
Improved coffee variety	196	58.16	41.9	60.7	71	11.57***
Type of coffee processing:						
Washing(wet processing)	3	0.89	0	0	2.3	0.86
Drying	274	81.3	83.8	93.3	71	9.42***
Both	60	17.8	16.2	6.7	26.7	7.64***
Type of coffee harvesting:						
Strip harvesting	73	21.66	23.6	13.5	11.63	5.8***
Selective Harvesting	208	61.72	53.7	60.2	70.9	5.9***
Both	56	16.62	7.7	24.7	19.1	5.91***

Source: Own computation results based on survey data, 2015

4.2. Technical Efficiency of Smallholder Coffee Growers

4.2.1. Technical efficiency estimation results

Before presenting the maximum likelihood results of the technical efficiency of sample households, it is important to present the summary statistics of output and input data (Table 13). The mean coffee yield (dry parchment coffee) across the sample households is 734.82 kg per hectare with a standard deviation of 343.15 kg per ha. But, there exists a big difference in coffee production among the sampled households with a minimum of 119.2 kg of dry parchment coffee and maximum of 1982.4 kg of dry parchment coffee per hectare. Regarding inputs of production, the mean organic manure applied per hectare was about 19.64 quintals with a standard deviation of 13.82. The maximum amount of organic manure applied per hectare was 96 quintals and there are farmers who do not apply any organic manure on their coffee farms. The other input applied at coffee farms by sample households is labour measured in man days per hectare per year. The annual mean labour applied on coffee farms was 76.3 man days per hectare with a standard deviation of 50.34 man days per year. The maximum and minimum labour applied in terms of man days per ha per year is 225 and 33,

respectively. Moreover, the F-test result indicates that all input variables and coffee production vary significantly across sample woredas at one percent level of significance.

Table 13. Summary statistics of coffee output and inputs utilized by the sample households

Variable	Total				Woredas			F-test
	Mean	Std. Dev.	Min	Max	Chena (mean)	Decha (mean)	Gimbo (mean)	
Coffee production in kg/ha	734.8	343.2	119.2	1982.4	622.3	843.8	1018.5	54.32***
Organic manure in quintal/ha	19.6	13.8	0.0	96	19.4	15.4	22.7	7.68***
Labour in man days per year per ha	76.3	50.0	33.0	225	79.3	57.9	86.3	9.25***
Coffee land size in ha	1.2	1.0	0.1	8.25	1.2	1.8	0.9	14.39***
Average age of coffee tree (years)	26.56	5.1	5.2	45.9	32.61	24.22	18.53	34.2***

Source: Own computation results based on survey data, 2015

The maximum likelihood estimates of the selected Cobb-Douglas type of production function is shown in Table 14. The standard ordinary least squares (OLS) estimate is also presented for comparison. The ratios of the estimated coefficients to their corresponding standard errors which provide Z-ratios are used to test the statistical significance of the estimated parameters. The parameter estimates for all the conventional inputs such as organic manure, coffee land size and labour in man days turned out to be significant in agreement with a *priori* expectation. The ML estimates of the β parameters show that among the conventional inputs, labour and organic manure were found to be positive and significant at 1 percent and coffee land size was found to be positive and significant at 10 percent significance level.

The magnitude of the coefficient for organic manure which was 0.12 indicates that output (dry parchment coffee in kg per hectare) was relatively more responsive to changes in the amount of organic manure applied. Thus, a one percent increase in organic manure in terms of quintals per hectare would induce a 12 percent increase in the output of coffee. The magnitude of the coefficient for labour in man days which was 0.09 indicates that coffee output was relatively more responsive to changes in man days of labour than to changes in coffee land size. Hence, a one percent increase in man days of labour, *ceteris paribus*, would also increase coffee output by 9 percent.

The magnitude of the coefficient of land, which is 0.01, indicates that coffee output is less responsive to changes in coffee land size than organic manure applied per hectare. Thus, 0.01 elasticity of land implies that a 1% increase in cultivated coffee land area, *ceteris paribus*, would lead to an increase of one percent in the coffee output. Hence it can be said that given the specification of Cobb-Douglas frontier model, the result shows the elasticity of the mean value of coffee output for all three conventional inputs used in the production function.

Regarding age of coffee tress, the mean average age of coffee tree for the sample woredas is about 26.6 years with a significant mean difference in the age of coffee trees between the study woredas at one percent level of significance. The highest and the lowest mean age of coffee tree were observed in Chena and Gimbo woredas with 32.6 and 18.5 years, respectively.

Moreover, as shown in Appendix Table 12, the mean technical efficiency of sample households with a cultivated coffee land area of size $[0.125-0.5]$, and $(0.5-1.0]$ hectares was 61 and 64 percent, respectively. And those households with more cultivated areas of coffee land such as $(1.0-3.0]$ and $(3.0-8.25]$ hectares have had a mean technical efficiency level of 65 and 71 percent, respectively. From these, one might infer that households with larger coffee land sizes are more efficient than those with smaller cultivated coffee farm size in the study areas. This finding might imply that smallholder coffee growers with large coffee farm size have more resources which enable them to employ efficiency enhancing technologies as compared to their counterparts operating on small land holdings.

Table 14. ML and OLS estimates of a stochastic production frontier/half-normal model

Production function	ML estimates		OLS estimates
	Coef. (Std. Err.)	P-value	Coef. (Std. Err.)
Variables			
ln (organic manure)	0.30*** (0.061)	0	0.43*** (0.067)
ln (coffee land size)	0.05* (0.026)	0.076	0.10** (0.041)
ln (labour)	0.13*** (0.03)	0	0.12*** (0.034)
Constant	5.59*** (0.214)	0	4.78*** (0.237)
δ_v	0.16 (0.023)		
δ_u	0.64 (0.038)		
δ^2	0.43 (0.044)		
lambda = $\lambda = \delta_u / \delta_v$	3.97 (0.054)		
Gamma = $\left[\frac{\lambda^2}{1 + \lambda^2} \right]$	0.940*** (.023)		
LL	-161.74		

***, ** and * indicates significance at 1, 5 and 10 percent, respectively.

Source: Own model result based on survey, 2015

The likelihood ratio chi-square of 44.93 (df=1) with a p-value of 0.000 tells us that the stochastic frontier/half-normal model as a whole fits significantly better than a model with no predictors. As mentioned before, the most well-known strategy for disentangling this unobserved component from the compounded error is required. Hence, point estimates of technical efficiency in this study were measured using the mean $E(u/\hat{\varepsilon})$ of this conditional distribution.

The presence or absence of technical inefficiency was tested using the important parameter of log likelihood in the half normal model $\lambda = \delta_u / \delta_v$. If $\lambda = 0$ there are no effects of technical inefficiency, and all deviations from the frontier are due to noise (Aigner *et al.*, 1977). The estimated value of $\lambda = 3.97$ was significantly different from zero (Table 14). Moreover, the presence or absence of technical inefficiency was tested in the study using z test. The null hypothesis is that there is no inefficiency effect in the model. The estimation result from equation (13) shows that $Z_{\text{statistic}} = \frac{\bar{\lambda}}{s_e(\bar{\lambda})} =$

$3.97 / 0.054 = 73.52$. At the significance level of 0.01, the critical value is $Z\alpha/2 = 2.58$. The calculated

value $Z_{\text{statistics}}$ is greater than $Z_{\text{critical value}}$. Therefore, the null hypothesis was rejected at 0.01 level, suggesting the presence of technical inefficiency effect for smallholder coffee growers in the study area. Additionally, the estimated value of gamma (γ) is 0.94, which is an estimate of the variance parameter and significant at 1% level of significance. This value shows that 94% of the total variation in output is due to an existence of technical inefficiency. This demonstrates essentially almost all departures from the estimated production frontier are caused by systematic technical inefficiency rather than random disturbances.

The frequency distribution of technical efficiency for sample households is presented in Table 15, based on the estimate of the stochastic frontier function using half-normal distribution of the inefficiency term. The study reveals that technical efficiency (TE) of sample households ranges from 15 percent to 94 percent, with mean technical efficiency of 64 percent. It is implied that the average coffee grower in the sample could increase productivity by 32 percent (i.e., $1 - [64/94]$) and the most technically inefficient could realize 84 percent productivity increment (i.e., $1 - [15/94]$) compared with the TE level of the most efficient counterpart. In addition, the highest TE level ranging from 65 percent to 94 percent comprises 54.3 percent of the total sample households. The lowest TE score of fewer than 30 percent comprises 5 percent of sample households indicating that almost half of the sample households achieve higher than the average mean TE score.

Table 15. Frequency distribution of technical efficiency for sample households

TE Level in %	Number of HHs	Percent (%)
15≤30	17	5.0
>30≤65	137	40.7
>65≤95	183	54.3
Mean TE (%)	64	
Minimum TE (%)	15	
Maximum TE (%)	94	

Source: Own model result based on survey, 2015

4.2.2. Determinants of technical inefficiency

The effects of distributional assumptions of the inefficiency error term on technical efficiency of

smallholder coffee growers was compared and half-normal distribution assumption was selected for analytical purpose based on the characteristics they are having with the data set. Actually, from the literature; there are four distributional assumptions attached to inefficiency effects error term namely, half-normal, truncated normal, exponential and gamma. Prior to explaining the result of the model, tests on multicollinearity and heteroscedasticity were made. The VIF was found to be low with a mean VIF of 1.44) (see Appendix Table 11). Hence, there is no problem of multicollinearity in the data set for identifying factors affecting the technical inefficiency. In addition, a test for normality of technical inefficiency was made using Kernel density estimate. Kernel density estimate graph resembles the normally distributed curve (see Appendix Figure 3).

Table 16 presents the summary statistics of technical efficiency distribution under three distributional assumptions attached to inefficiency effect error term. As shown in Table 16, there is a slight mean variation of technical efficiency across various distributional assumptions. The descriptive statistics from half normal, truncated normal and exponential, on average, reveals about 35%, 32% and 28% of output is lost due to technical inefficiency of smallholder coffee growers, respectively.

Table 16. Summary statistics of technical efficiency distribution by different assumptions

Descriptive Statistics	Half-normal	Truncated -normal	Exponential
Mean	0.6460	0.6814	0.7200
Std. Dev.	0.1915	0.1885	0.1802
Min	0.1562	0.1654	0.1719
Max	0.9435	0.9411	0.9390

Source: Own computation results based on survey data, 2015

The study examined the determinants of technical inefficiency using the Tobit model. The coefficients of the explanatory variables in the inefficiency model and the marginal effects/elasticity are of particular interest to this study. In explaining the influences of independent variables, it is important to note that a negative sign of a coefficient means that the predicted effect on inefficiency is negative, i.e. the variable has a positive effect on technical efficiency and the positive coefficient means that the predicted effect on inefficiency is positive i.e. the variable has a decreasing effect on technical efficiency. The signs of most of the explanatory variables for the inefficiency model were as expected.

Using Tobit model, the inefficiency scores were regressed on socio-economic, farm and household

characteristics. The Tobit model result depicted in Table 17 shows that educational status, cooperative membership, number of coffee plots, pruning, improved varieties of coffee, credit utilization, intercropping, mobile ownership, age of coffee trees, and the location of households are the significant variables that determine the TE of sample households in the study areas.

Table 17: Determinants of technical inefficiency model using Tobit

Inefficiency scores(dependent variable)	Coef.	Std. Err.	Marginal Effects		
			dy/dx	ey*/ex	dy/dx(a-b)
Sex (1=Male, 0 =Female)	0.015	0.017	0.015	0.037	0.001
Education (1=literate, 0 = illiterate)	-0.063***	0.014	-0.063	-0.088	-0.004
Cooperative membership(1= yes, 0 =No)	-0.049**	0.016	-0.049	-0.092	-0.003
HH size (number)	-0.006	0.003	-0.006	-0.098	-0.001
Coffee plot (number of plots)	0.036***	0.007	0.036	0.166	0.002
Pruning (1= Yes, 0 = No)	-0.096***	0.015	-0.096	-0.174	-0.005
Intercropping (1= Yes, 0 = No)	0.026*	0.013	0.026	0.041	0.002
Mulching (1= Yes, 0 = No)	-0.017	0.014	-0.017	-0.028	-0.001
Improved variety (1= Yes, 0 = No)	-0.079***	0.016	-0.079	-0.130	-0.005
Training (years)	-0.005	0.003	-0.005	-0.054	-0.000
Extension visit (frequency)	0.003	0.003	0.003	0.042	0.0002
Average age of coffee trees (in years)	0.010***	0.002	0.010	0.061	0.001
Experience (in years)	0.000	0.001	0.000	0.005	0.000
Oxen (numbers)	0.002	0.006	0.002	0.016	0.000
Mobile ownership(1= Yes, 0 = No)	-0.026*	0.013	-0.026	-0.051	-0.001
Distance to coffee plots(kms)	0.002	0.001	0.002	0.006	0.0001
Credit utilization (1= Yes, 0 = No)	-0.027*	0.012	-0.027	-0.038	-0.002
Chena (1= Yes, 0 = No)	0.065***	0.016	0.065	0.063	0.002
Decha (1= Yes, 0 = No)	-0.033***	0.009	-0.033	-0.049	-0.003
_cons	0.395***	0.039			
LR chi2(19)	418.08				
Prob > chi2	0				
LL	283.36				
Left-censored	1				
Uncensored	335				
Right-censored	1				
Sigma	0.103***	0.004			

***, ** and * indicate the level of significance at 1, 5 and 10 percent, respectively.

Source: Own computation result based on survey data, 2015

Note: The three marginal effects computed for the explanatory variables (dy/dx) is the total change, (ey*/dx) is the expected change on the latent variable, (dy/dx(a-b)) is the change between the

minimum and maximum TI effects i.e. the probability to fall under TI.

The Tobit model result shows that the educational status of sample households was negative and significant at 1 percent level of significance and found to be consistent with our *a priori* expectation. The negative coefficients on education imply that literate households are more likely to apply technical knowledge to coffee production. Moreover, it suggests that better educated household head can understand agricultural instructions easily, have higher tendency to adopt improved agricultural technologies, have better access to information, and are able to apply technical skills imparted to them than uneducated ones. Thus, the level of education of household head emerges as an important factor in enhancing the technical efficiency of coffee production in the study areas.

Being literate would decrease the probability of the household to fall under technical inefficiency (TI) by 0.4 percent and change in the expected value of TI by about 8.8 percent with an overall decrease in the probability and level of TI by 6.3 percent. Thus, sample households who are literate, are technically efficient than households who are illiterate. This finding is in agreement with the findings of Poudel *et al.* (2015) and Thong *et al.* (2014) who reported a negative relationship between education and technical inefficiency among smallholder coffee farms in Peru and Vietnam, respectively. This result suggests that increasing formal education in the study area tends to significantly increase the technical efficiency of smallholder coffee growers.

The relationship between inefficiency effects and membership in a cooperative is negative and statistically significant at 1 percent significance level. Cooperative membership is used as a proxy for measuring the role of association in the production process. Households' who are members of farmer cooperatives are expected to receive viable information on production technologies than farmers who are not members of the cooperatives. As a result, cooperative member households tend to be more progressive, and apply new production technologies and hence, are more efficient in coffee production. Moreover, the marginal effect of cooperative membership as depicted in Table 17 indicates that being a cooperative member by a household decreases the probability of the household to fall under TI by 0.3 percent and change in the expected value of TI by about 9.2 percent with an overall decrease in the probability and the level of TI by 4.9 percent. This result suggests that promoting cooperatives is quite important to enhance technical efficiency of smallholder coffee growers.

Sample household heads were asked to indicate if they adopted any of the improved agricultural technologies (i.e. utilization of improved varieties of coffee, over the last three years) that have been promoted by the government. We see a negative and significant relationship between the adoption of improved coffee varieties and technical inefficiency effects at 1 percent level of significance, in harmony with our *a priori* expectation. The marginal effect result shows that sample households who adopted improved varieties of coffee decreases the probability of the household to fall under TI by 0.5 percent and change in the expected value of TI by about 13 percent with an overall decrease in the probability and the level of TI by 7.9 percent. In other words, closer scrutiny of Tobit model results portray that adopting improved varieties of coffee would increase the technical efficiency level of smallholder coffee growers in the study area.

As expected, we also see a negative and significant relationship between pruning practice and technical inefficiency at 1 percent level of significance. As indicated in many plant science text books, pruning of coffee trees is a necessary technique that is not only required to maintain healthy tree but keeps quality and quantity at its highest levels. Another benefit of pruning is that since the pruned trees grow and remain straight, the rows remain open. This makes tasks such as picking, ground cover control, and coffee management in general much easier. In line with the above statement, our study reveals that pruning practice decreases the probability of the household to fall under TI by 0.5 percent and change in the expected value of TI by about 17.4 percent with an overall decrease in the probability and the level of TI by 9.6 percent than those who do not practice pruning. This result is in conformity with the works of Coelli *et al.* (1998) who argued that productive efficiency is commonly associated with the management skills of the farmer.

Access to credit and its utilization affects technical inefficiency negatively and significantly at 5 percent level of significance. The marginal effect shows that having access to credit decreases the probability of the household to fall under TI by 0.2 percent and change in the expected value of TI by about 3.8 percent with an overall decrease probability and level of TI by 2.7 percent. This can be explained as utilization of loaned credit helps to mitigate financial problems that farmers may face during the production period by enabling them purchase more of the needed inputs. This is similar to the results obtained by Nachare (2007) and Thong *et al.* (2014) for the analysis of factors affecting the technical efficiency of coffee production in Cameroon and Vietnam, respectively. They found a positive and significant relationship between access to credit and technical efficiency of coffee

growers. They argued that access to adequate credit permits a farmer to enhance efficiency by overcoming liquidity constraints which may affect their ability to apply inputs and implement farm management decisions on time. Access to credit therefore loosens financial constraints, ensures timely acquisition and use of inputs and results in increased technical efficiency among smallholder coffee growers in the study area.

As predicted, the other variable that affects level of technical inefficiency is the number of coffee plots that sample households do have. We have found positive and significant relationship between the number of coffee plots and technical inefficiency effects at 1 percent level of significance. The marginal effect shows that a unit increase in the number of coffee plots would increase the probability of the household to fall under TI by 0.2 percent and change in the expected value of TI by about 16.6 percent with an overall increase in the probability and level of TI by 3.6 percent. This might be due to the fact that when a household have more number of coffee plots, households face coordination problems, more transaction costs and unable to utilize their inputs optimally.

This study also shows that smallholder coffee growers who do practice intercropping with other crops are more technically inefficient. There exist a positive and statistically significant relationship between the intercropping practice and the inefficiency effects at five percent level. The marginal effect shows that households who intercrop their coffee trees with other crops would increase the probability of the household to fall under TI by 0.2 percent and change in the expected value of TI by about 4.1 percent with an overall increase in the probability and level of TI by 2.6 percent. This might be due to the fact that coffee is intercropped with any kind of crop like maize, beans (soybean, haricot bean), papaya, red pepper, spices etc. without any consideration about its compatibility and proportion (intercropping ratio). In conformity with this result, Nginyangi (2011) found that intercropping coffee with other crops was shown to have a significant negative influence on economic efficiency. The result implies that intercropping doesn't have positive effects on technical efficiency of coffee in the study area. Thus, smallholder coffee growers could be able to benefit more by making use of the available space in coffee farm without any (significant) efficiency loss.

As our *priori* expectation, there exist a positive and statistically significant relationship between the average age of coffee tree and the inefficiency effects at 1 percent level of significance. This means that households who do have older coffee trees are more technical inefficient than households with younger coffee trees. The marginal effect shows that a one year increase in the age of a coffee tree

would increase the probability of the household to fall under TI by one percent and change in the expected value of TI by about 6.1 percent with an overall increase in the probability and level of TI by one percent. This might signify the biological nature of coffee production where to some level of years, coffee production increases and then after, it declines depicting a diminishing marginal productivity as the age of coffee tree gets old.

Ownership of mobile phones for accessing marketing information has a negative and statistically significant effect on TI at five percent levels of significance. The result implies that a household who owns a mobile phone has better market information access and hence less likely to be technically inefficient in coffee production than those households who did not own mobile phones. Moreover, ownership of mobile phones would decrease the probability of the households to fall under TI by about 0.1 percent and change the expected value of TI by about 5.1 percent with an overall decrease in the probability and levels of efficiency by 2.6 percent.

Finally, in this study, both positive and negative significant relationship has been found between the location of the sample households and technical inefficiency effects in Chena and Decha woredas, respectively at one percent level. The marginal effect result indicates that being a household at Chena woreda would increase the probability to fall under TI by about 0.2 percent and change the expected value of TI by about 6.3 percent with an overall increase in the probability and levels of TI by 6.5 percent. On contrary, being a household at Decha woreda would decrease the probability to fall under TI by about 0.3 percent and change the expected value of TI by about 4.9 percent with an overall decrease in the probability and levels of TI by 3.3 percent. This is because of proximity to the zonal town Bonga and there are higher members of cooperative in Decha woreda than Chena.

Variables such as sex, HH size, experience in coffee production, mulching, frequency of training received, extension contact, number of oxen and distance to coffee production are not statistically different from zero. This implies that in the study areas these factors did not significantly determine technical inefficiency of coffee production. Similarly, Poudel *et al.* (2011) research in Nepal showed that the effect of farmers experience, and sex were not significant on efficiency of coffee production.

4.2.2. Coffee yield gap due to technical inefficiency

Coffee yield gap might be defined as the difference between technically full efficient coffee yield and

observed coffee yield in terms of kg per hectare.

Based on equation (15) of the methodology section and using the values of actual coffee yield obtained and the predicted technical efficiency indices, the potential coffee yield was estimated for each household on hectare basis. The mean result of the yield gap is presented in Table 18 below.

Table 18: Coffee yield gap due to technical inefficiency and difference between woredas

Variable	Total					woredas			F-test
	Mean	Std. Dev.	C.V.	Min	Max	Chen	Decha	Ginbo	
Actual Yield (kg/ha)	734.8	343.2	0.47	119.2	1982.4	622	843.8	1018.5	54.3***
Mean TE	0.64	0.19	0.30	0.15	0.94	0.52	0.72	0.71	55.6***
Potential Yield/ y'/ha	1287.2	322	0.25	648.6	2319.2	1199	1180.1	1438.5	27.52***
Yield gap (y/ha)	552.3	264.2	0.48	97.4	1544.3	577	336.3	420.0	25.89***

Source: Own computation based on survey data, 2015

It was observed that mean technical inefficiency was 36 percent which caused 552.3 kg/ha yield gap of coffee on the average with mean value of the actual output and the potential output of 734.8 kg/ha and 1287.2 kg/ha, respectively. This shows that sample households in the study areas were producing on the average 552.3 kg/ha lesser coffee output than the potential yield.

Regarding TE and productivity differential, as it is depicted in Table 18, the F-test statistics is significant for all variables at one percent level of significance. This indicates that there exist a TE and productivity differential between the sample woredas.

4.3. Households' Perceptions about Sources of Risks and Risk Management Strategies

In this section, descriptive statistics about households' mean ranking of risk sources and risk management strategies and econometric results, multivariate ordered probit and multivariate probit results are presented.

4.3.1. Households perceptions about major sources of risks

A number of variables that measured shocks in the year of coffee production were included. We asked sample households to indicate (if rains in the coffee production season (i.e. 2014/15) were normal, if coffee beans were affected by hailstorms and frosts, if they were affected by diseases and pests, and if there were losses because of wild animals (e.g., monkeys and apes).

Regarding loss of coffee beans by hailstorms and frosts, only 8 percent of the sample households perceived that coffee beans in their plots were highly affected and 48 percent of households said the effect of hailstorms and frosts on coffee beans were minimal in the production season. Moreover, 43 percent of sample households indicated that their coffee beans are not totally affected by hailstorms and frosts. About 64.7 percent of sample households perceived that the effect of diseases and pests on coffee production was less in 2014/15 production season. Whereas 10.7 percent of sample households perceived that their coffee production was highly affected by diseases and pests than it was in the last three years. However, the remaining 24.6 percent of households said coffee production in that season was not affected by diseases and pests. Moreover, majority of the sample households indicated that there were coffee losses in the production season due to an attack by wild animals.

Table 19. Households' perceptions about different shocks on coffee plots

Items	Affected less		Affected more		Not affected		Total	
	Freq	%	Freq	%	Freq	%	Freq	%
Affected by frost	165	48.96	27	8.01	145	43.03	337	100
Affected by diseases and pest	218	64.7	36	10.7	83	24.6	337	100
Affected by wild animals	167	49.6	100	29.7	70	20.7	337	100

Source: Own computation result based on survey data, 2015

As shown in Table 20 about 40.65 percent of sample households perceived the rains in the production season (i.e. in 2014/15) was less and 37.09 percent of sample households perceived the distribution and amount of rain were uniform over the last three years (see Table 19). But, 22.26 percent of sample households perceived that the amount and distribution of rains in the production season were higher than what has been observed over the last three years.

Table 20: Households' perceptions about Rainfall normality

Rainfall Normality	Less than normal		More than normal		Uniform		Total	
	Freq	%	Freq	%	Freq	%	Freq	%
	137	41	75	22	125	37	337	100

Source: Own computation result based on survey data, 2015

Table 21 illustrates sample households' perception to changes in coffee prices. Households were asked about the volatility of coffee prices as compared to that of other cereal crops. About 48 and 45 percent of households perceived that coffee prices were highly and moderately volatile, respectively. However, 4.2 percent of households reported that cereals and coffee prices were equally volatile and 2.7 percent of the sample households claimed that coffee prices were not volatile as compared to price volatility of the cereals.

Table 21. Households' Perceived price volatility of coffee against cereals

Coffee Price volatility compared to price volatility of cereals	Highly volatile		Moderately volatile		Equally volatile		Not volatile		Total	
	Freq.	%	Freq.	%	Freq	%	Freq	%	Freq.	%
	162	48	152	45	14	4.2	9	2.7	337	100

Source: Own computation result based on survey data, 2015

Sample households were also requested to compare the current coffee prices (i.e. prices during data collection, 2014/15) with coffee prices before 5 year (i.e. coffee prices in 2010) and with the future prices of coffee (i.e. prices in 2020). Accordingly, as depicted in Table 22, 41.54 percent of sample households responded that coffee prices in 2015 are higher than the 2010 prices. About 44.21 percent of sample households replied that the current coffee prices are equally volatile as compared to the volatility of coffee prices in 2010. About 12.46 percent of sample households indicated that there is no significant difference in coffee prices during the two periods and 1.78 percent responded that they do not know whether there exists a price difference among the two periods. Regarding sample households perception about future coffee price changes, the majority (62.31 percent) perceive coffee prices will be higher in 2020 than coffee prices in 2015. In contrast, 7.7 percent of households perceived that there will not be a coffee price change and about 23.44 percent of sample households perceived that coffee prices will plummet in 2020. However, 6.5 percent of households perceived that they do not know what would happen to the prices of coffee in 2020.

The expectation of low future coffee prices could hamper important investments in renovation of coffee plantations. The expectation might further lead to the abandonment of coffee production as farmers may switch to presumably more profitable agricultural crops. Consequently, expected low coffee prices could negatively affect the supply of high quality coffee beans and could have adverse effects on household income. In this regard, provision of correctly predicted future price becomes crucial to overcome the negative effects of low price expectations.

Table 22. Households' perceptions about past and future coffee prices

Coffee price comparison	2015's coffee price compared to 2010's		2020's coffee price compared to 2015's will be	
	Freq.	(%)	Freq.	(%)
Higher	140	42	210	62.4
The same	42	12	26	7.7
less	149	44.2	79	23.4
I don't know	6	1.8	22	6.5
total	337	100	337	100

Source: Own computation result based on survey data, 2015

Farming activity is exposed to the influence of different important sources of risks prevailing in agriculture. We have identified five primary sources of agricultural risk for sample households: production, financial, marketing, legal/institutional, and human related risks. To identify the determinants of households perception, sample households were asked to evaluate each of the five sources of risks in terms of its importance to their coffee farm business, using a five-point likert scale with 5 being the most important or critical to their coffee farm business and 1 being the least important.

As shown in Table 23, in terms of importance to their coffee farm business, sampled households perceived production risk with proportionate score of 0.41 as the first most important (y= 5) perceived source of risk affecting their coffee farm business and market risk as the second most important perceived source of risk with proportionate score of 0.21. In terms of importance to coffee farm business, institutional, financial, and human related risks were perceived and ranked as the third, fourth and fifth most important sources of risk with proportionate score of 0.17, 0.16 and 0.05 respectively. Similarly, Ejigie (2005) had found production risks represented by coffee berry disease

and coffee wilt diseases and market risks such as output and input prices were the most relevant risks which were perceived by Ethiopian coffee farmers.

Martin (1996), using a nationwide mail survey, examined the sources of risk and the risk management strategies of New Zealand farmers. His survey covered eight types of farm including sheep and beef, dairy, deer, pip fruit, kiwi fruit, cropping, vegetables and flowers. His findings showed that market risk (such as change in product prices and change in input costs) was ranked as a very important source of risk by all farmers. On the contrary, production risks (such as rainfall variability, weather, and pests and diseases) were regarded differently depending on geographical location, farm type and product. Findings in the present study reveal that sample households are less concerned about the effect of the country's institutional policies and regulations on their coffee farm business as compared to weather related risks.

Production risk as explained by Harwood *et al.* (1999) can be measured by yield variability using farm or national level data. At the household level, the coffee yield variability is often measured by an indicator known as coefficient of variation (CV) is about 46 percent from the mean yield across the sample households in terms of yield per hectare (see Table 18). This indicates that there is high coffee yield variability among sample households in the study area. Subsequently, the presence of coffee yield variability shows the existence of production risk in coffee farm business.

Table 23. Descriptive statistics of households' perceptions about major sources of risk

Sources of major risks	Rank	Proportion	Std. Err.	[95% Conf.	Interval]
Production Risk	Y=1	0.006	0.004	0.001	0.024
	Y=2	0.003	0.003	0.000	0.021
	Y=3	0.139	0.019	0.106	0.181
	Y=4	0.445	0.027	0.393	0.499
	Y=5	0.407	0.027	0.355	0.460
Financial Risk	Y=1	0.142	0.019	0.109	0.184
	Y=2	0.148	0.019	0.114	0.191
	Y=3	0.433	0.027	0.381	0.487
	Y=4	0.113	0.017	0.083	0.151
	Y=5	0.163	0.020	0.127	0.207
Market Risk	Y=1	0.053	0.012	0.034	0.083
	Y=2	0.163	0.020	0.127	0.207
	Y=3	0.279	0.024	0.233	0.329
	Y=4	0.297	0.025	0.250	0.348
	Y=5	0.208	0.022	0.168	0.255
Institutional Risk	Y=1	0.226	0.023	0.184	0.273
	Y=2	0.481	0.027	0.428	0.534
	Y=3	0.053	0.012	0.034	0.083
	Y=4	0.071	0.014	0.048	0.104
	Y=5	0.169	0.020	0.133	0.213
Human Related Risk	Y=1	0.573	0.027	0.519	0.625
	Y=2	0.205	0.022	0.165	0.251
	Y=3	0.095	0.016	0.068	0.131
	Y=4	0.074	0.014	0.051	0.108
	Y=5	0.053	0.012	0.034	0.083

Source: Own computation result based on survey data, 2015

Note: y =1: least important, y = 2: less important, y =3: important, Y= 4: more important, y =5: most important

The national coffee yield variability in terms of tons, measured by CV using data obtained from World Bank for the year 1961-2013 is about 42 percent from the average national coffee yield (see Appendix Table 9). Though, the estimated value of CV for the national and survey samples is high, there is no as such a significant difference between the household and national level data in terms of yield variability.

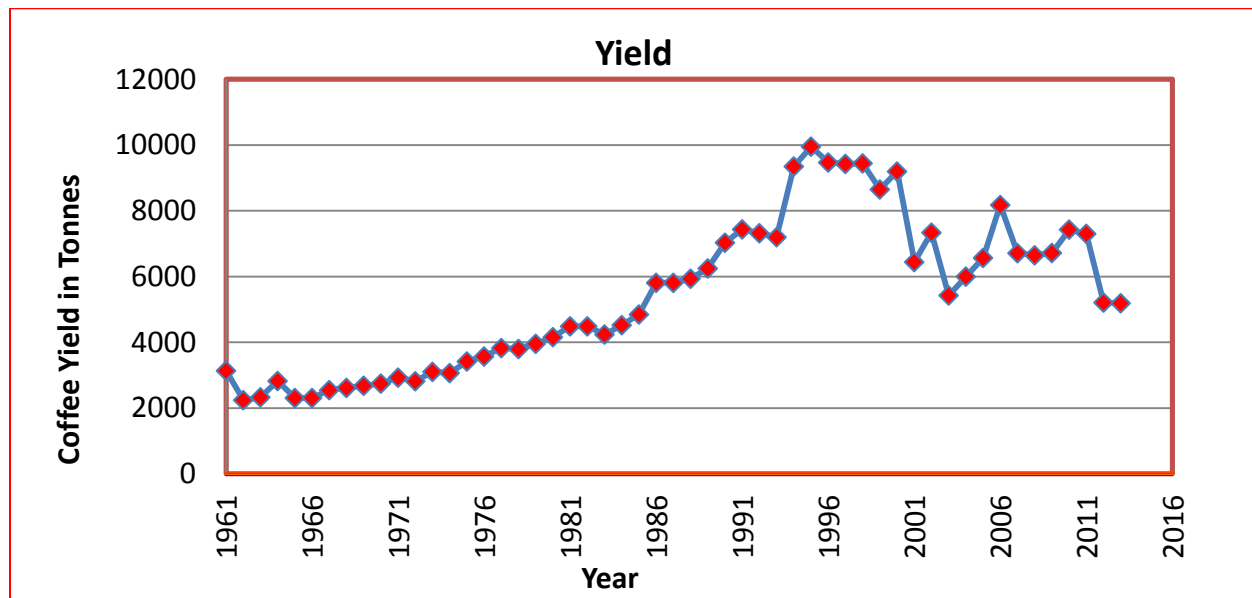


Figure 7. Ethiopia's national coffee yield for the year 1961-2013

Source: Own construction based on the data obtained from (FAOSTAT, 2016)

4.3.2. Determinants of households' perceptions about sources of risks

This section describes the determinants of sample households' perceptions about the five major sources of risk that affect coffee farm businesses. Tables 23 illustrate the multivariate ordered probit model results about the determinants of households' perception to five major sources of risk. Similarly, marginal effects at mean values were calculated for sources of risks on five point likert scale. Smallholder coffee farmers are exposed to the influence of different sources of risks prevailing in agriculture.

In this section, multivariate ordered probit regression model result on the determinants of households' perception about sources of risk is presented. In this model, households' farm and socio-economic factors were considered for analyzing the determinants about sources of five major agricultural risks. The estimated model is highly significant, with a likelihood ratio test of the hypothesis that all the coefficients are zero is rejected based on LR chi-squared value of 557.46 with 95 degrees of freedom (see Table 23).

4.3.2.1. Determinants of households' perceptions about production risks

Sample households' perception towards production risks as an important source of coffee farm risk is

determined by factors such as sex of a household head, age, livestock holding, perceived amount of precipitation, technical efficiency level as proxied by score, location and household's attitude about loss of coffee by diseases and pest infestation.

As can be seen from the same Table 23, the result indicates that the age of a household has been found to positively and significantly determine households' perception about production risks at 1 percent level of significance. This is in conformity with our *priori* expectation. The marginal effect shows that being male household more likely increases the probability of reporting production risk as the most important source of risk by 19.9 percentage points.

As expected, age of a household head has been found positively and significantly influencing households' perception about production risk as the most important source of risk, at 1 percent level of significance. The marginal effect indicates that a one year increment in the age of a household would increase the probability of perceiving production risk as an important source of risk by 0.02 points. This implies that older households perceive production risk as the most important source of coffee farm risk than the younger ones.

Livestock holding has been found positively and significantly influencing household's perception about production risks as the most important source of coffee farm risk at 5 percent level of significance. In other words, households with higher livestock holding perceived production risks to be greater compared to farmers with lower number of livestock units; possibly, farmers with more livestock are also more production –oriented. A unit increase in the livestock holding increases the likelihood of reporting production risk as the most important source of risk by 2.6 percentage points.

The other important factors that affect households' perception towards production risk as the most important source of coffee farm risk are households' perception about the amount of precipitation and loss of coffee due to coffee diseases and pests. Households who perceived the amount of precipitation as low compared to precipitations in the last 3 previous years are 53.5 percentage points more likely report production risk as the most important source of coffee farm risk. And those households who perceived coffee diseases and pests have attacked their coffee production are 25.2 percentage points more likely indicate production risk as the most important source of coffee farm risk. As indicated by FAO (2008), put forth that the relative importance of the different sources of risk depends on the nature and attitudes of the individual farmer and the farm household towards risk.

The other important result is that there exists a positive and significant relationship between predicted technical efficiency scores and their perception of ranking production risk as the most important source of risk. The marginal effect result indicates that a percentage increase in the technical efficiency score of a household increases the likelihood of reporting production risk as the most important source of coffee farm risk by 59.6 percentage points. In other words, this means that technically efficient households are more likely to report production risk as the most important source of risk.

Additionally, households in Chena Woreda perceived production risk as less important compared to those in other Woredas. The marginal effect result illustrates that households located in Chena woreda are 16.1 percentage points less likely perceived production risks as the most important but 2.9 percent more likely perceived production risk as the least important source of risk, respectively.

The rho value as shown in Table 23 indicates that household perceptions about production risks are negatively and significantly correlated with their perceptions to institutional and human related risks. This implies that households that perceive production risk as the most important source of risk to their coffee production perceive institutional and human related risks as the least important source of risk.

4.3.2.2. Determinants of households' perceptions about market risks

As indicated in the descriptive analysis, market risks are the second most important perceived source of risk by sample households with a mean score of 3.49 to their coffee operation. This finding is consistent with the results of Patrick *et al.* (1985), Martin (1996), and Flaten *et al.* (2005) who argued that market risks associated with the variability of product and input prices are the most important sources of risk considered by farmers in their respective study areas.

In the multivariate ordered probit model, households' farm and socio-economic factors were considered for analyzing the determinants of market risk as an important source of risk for smallholder coffee growers. Results in Table 23, reveal that sample households perception about market risk where $Y=5$, represents a household has chosen market risk as the most important source of coffee farm risk and $Y=1$ represents a household has chosen market risk as the least important source of coffee farm risk. Thus, as shown in the same Table 23, households' perception about

market risk is determined by factors such as, family size, mobile ownership (as a source of market information), location, households' attitude towards coffee price change and coffee price volatility compared to prices of other cereal crops.

Household size determines households' perception towards market risk as the most important source of coffee farm risk at 5 percent level of significance. Respondents with larger family size perceived market risks to be most important compared to those with smaller families. A unit increase in family size increases the probability of reporting market risk as the most important source of risk by 1.5 percentage points. This is due to the fact that the more the family size, there will be a higher chance of getting information about coffee price/input variability (market risk).

Households' view about the current coffee price change compared to coffee prices before five years (comparison of 2015's price versus 2010s price), coffee price volatility compared to that of cereal prices, and years of mobile use are found to be positive and significant at 1 percent significance level. Sample households that recognize a higher coffee price change during data collection (2015) compared to coffee prices in 2010 more likely perceived market risks as the most important source of risk at 1 percent level of significance. The marginal effect indicates that these households are 20.6 percentage points more likely perceived market risks as the most important source of risk to their coffee farm business. The same result indicates that these households are 3 percentage points less likely perceived market risks as the least important source of risk to their coffee farm business.

Sample households who observed higher coffee price volatility compared to prices of other crops perceived market risks as the most important source of risk at 1 percent level of significance. Actually, this result is consistent with the responses of the focus group discussants and key informants who argued that coffee price volatility is high compared to the price volatility of other cereal crops. The marginal effect indicates these households are 14.9 percentage points more likely to perceive market risks as the most important source of coffee farm risk. In the same way, these households 4.6 percentage points less likely to perceive market risk as the least important source of coffee farm risk.

As expected, mobile ownership as a source of market information have positively and significantly influenced households perception about market risks at 1 percent level of significance. Sample households who own mobile phones more likely perceived higher ranks in terms of importance of

market risk as a source of coffee farm risk. The marginal effect result indicates that households who own mobile phones, more likely perceived market risks as the most important source of risk by 14.9 percentage points. But having mobile decreases the likelihood of perceiving market risk as the least important source of risk by 4.2 percentage points. This might be because mobile ownership support smallholder coffee growers in revealing market information.

Moreover, households' location has been found to positively and statistically determine households' perception about market risks at one percent level of significance. Households who live in both Chena and Decha woredas are more likely perceived market risks as the most important source risk by 13.4 and 22.9 percentage points and at the same time these households less likely perceived market risks as the least important source of risk by 1.7 and 2.2 percentage points, respectively.

Similar to production risks, the rho values shown in Table 23 indicates that household perceptions about market risks are negatively and significantly correlated with their perceptions to institutional and human related risks. This implies that households that perceive market risks as the most important source of risk to their coffee production perceive institutional and human related risks as the least important sources of risk.

4.3.2.3. Determinants of households' perceptions about financial risks

In this part, households' farm and socio-economic factors were also considered for analyzing the determinants of sample households' perception to financial risk as a source of coffee farm risk (in terms of degree of importance). Results in Table 22, show that household's perception regarding financial risk as a vital source of risk is determined by factors such as, credit utilization, price information at primary markets and coffee price volatility compared to price of cereals. The multivariate ordered probit result reveal that sample households' who obtain price information at primary markets and households' perception about the importance of financial risks are negatively and significantly related at 5 percent level of significance. The marginal effect shows that sample households who obtained price information at primary markets more likely perceived financial risks as the most important source of risk to their coffee farm business by 6.3 percentage points than those who did not seek and obtain price information at primary markets. These households are 5 percentage points less likely to perceive financial risks as the least important source of risk to their coffee farm business. This is in agreement with our expectation this is due to the fact that these households do

have better access to information and there by perceived financial risks as the most important source of risk.

On the same side, sample households who believe that there exists coffee price volatility compared to price volatility of other cereals, more likely perceived financial risks as the most important source of risk. The marginal effect indicates that these households are 6.6 percentage points more likely perceived financial risks as the most important and 7.1 percentage points less likely as the least important source of risk, respectively.

The other determinant factor that influences households' perception of financial risk as the most important source of coffee farm risk is credit utilization. There is a positive and significant relation between credit utilization and households' perception about the importance of financial risk. The marginal effects result shows that households who receive and utilize credit for maintenance of coffee trees are 16.4 percentage points more likely to perceive financial risk as the most important source of coffee farm risk than those households who did not receive and utilized credit for intended purposes. This is due to that fact that these households claim the interest they pay for the credit they received from lending institutions was high and hence they perceived financial risks as the most important source of risk. Similarly, these households are 15.7 percentage points less likely to perceive financial risks as the least important source of risk.

Similar to both production and market risks, the rho values indicated in Table 23 show that household perceptions about financial risks are negatively and significantly correlated with their perceptions to institutional and human related risks. This implies that households that perceive financial risks as the most important source of risk to their coffee business perceive institutional and human related risks as the least important sources of risk.

Table 23. Determinants of households' perceptions about five major sources of risk (Continued on next page)

Production Risks		Coef.	Std. Err.	Marginal Effects(dy/dx)				
Variables				Pr(y=5)	Pr(y=4)	Pr(y=3)	Pr(y=2)	Pr(y=1)
Sex(1=Male, 0 =Female)		0.684**	0.214	0.199**	-0.144**	-0.055**	0.000	0.000
Age (years)		0.056***	0.010	0.021***	-0.018***	-0.003***	0.000	0.000
Education(1=literate, 0 = illiterate)		0.377	0.192	0.136	-0.116	-0.020	0.000	0.000
Cooperative membership (1= yes, 0 = no)		0.001	0.194	0.007	-0.006	-0.001	0.000	0.000
Pruning (1= yes, 0 = no)		0.363	0.191	0.113	-0.095	-0.019	0.000	0.000
Improved variety (1= yes, 0 = no)		-0.369	0.210	-0.121	0.105	0.016	0.000	0.000
Training received (1= yes, 0 = no)		-0.321	0.184	-0.114	0.100	0.014	0.000	0.000
Extension visit (frequency)		-0.071	0.040	-0.026	0.023	0.004	0.000	0.000
Livestock (in TLU units)		0.079*	0.039	0.026*	-0.023*	-0.004*	0.000	0.000
Credit utilization (1= yes, 0 = no)		-0.176	0.152	-0.067	0.057	0.009	0.000	0.000
Mobile ownership (1= yes, 0 = no)		0.032	0.164	0.010	-0.009	-0.001	0.000	0.000
Perceived precipitation (1=low, 0= otherwise)		1.828***	0.190	0.535***	-0.403***	-0.130***	0.000	0.000
Frost incidence (1= yes, 0 = no)		0.093	0.173	0.044	-0.038	-0.006	0.000	0.000
Disease & pest infest.(1= yes, 0 = no)		0.889***	0.228	0.252***	-0.194***	-0.058***	0.000	0.000
Attack (wild animals (1= yes, 0 = no))		-0.031	0.243	-0.006	0.005	0.001	0.000	0.000
Log coffee income		-0.679	0.374	-0.221	0.190	0.032	0.000	0.000
Efficiency scores		1.652*	0.767	0.570*	-0.489*	-0.081*	0.000	0.000
Chena woreda		-0.537*	0.221	-0.161*	0.132*	0.029*	0.000	0.000
Decha woreda		0.101	0.236	0.059	-0.051	-0.008	0.000	0.000
/cut1		-0.692	1.108					
/cut2		-0.497	1.100					
/cut3		1.527	1.095					
/cut4		4.071***	1.115					

Table 23. Determinants of households' perceptions about five major sources of risk (Continued on next page)

Market Risks		Coef.	Std. Err.	Marginal Effects(dy/dx)				
Variables				Pr(y=5)	Pr(y=4)	Pr(y=3)	Pr(y=2)	Pr(y=1)
Sex(1=Male, 0 =Female)		-0.225	0.186	-0.053	-0.036	0.042	0.040	0.007
Age (years)		-0.006	0.007	-0.001	-0.001	0.001	0.001	0.000
Education(1=literate, 0 = illiterate)		0.001	0.151	0.000	0.000	0.000	0.000	0.000
Cooperative membership (1= yes, 0 = no)		0.018	0.159	0.004	0.004	-0.003	-0.004	-0.001
Family size		0.066*	0.030	0.015*	0.013*	-0.012*	-0.013*	-0.003*
Training received (1= yes, 0 = no)		0.151	0.149	0.031	0.027	-0.024	-0.029	-0.006
Extension visit (frequency)		-0.024	0.031	-0.006	-0.005	0.004	0.005	0.001
Livestock (in TLU units)		-0.033	0.031	-0.007	-0.006	0.006	0.006	0.001
Credit utilization (1= yes, 0 = no)		-0.192	0.124	-0.041	-0.033	0.032	0.036	0.007
Mobile ownership (1= yes, 0 = no)		0.795***	0.144	0.149***	0.158***	-0.096***	-0.168***	-0.042***
Log coffee income		0.192	0.302	0.044	0.036	-0.034	-0.038	-0.007
Efficiency scores		-0.943	0.569	-0.207	-0.170	0.163	0.181	0.033
Price information at Primary markets (1=yes, 0= no)		-0.053	0.145	-0.013	-0.010	0.010	0.011	0.002
Government agent at primary markets(1=yes, 0= n0)		0.250	0.170	0.053	0.051	-0.040	-0.053	-0.011
Follow ECX price (1=yes, 0= no)		0.088	0.142	0.018	0.015	-0.014	-0.016	-0.003
Price change before 5 years (price is higher =1, 0= otherwise		0.870***	0.135	0.206***	0.132***	-0.152***	-0.156***	-0.030***
Coffee price volatility compared to cereals		0.856***	0.147	0.149***	0.165***	-0.093***	-0.175***	-0.046***
Chena woreda		0.570***	0.172	0.134***	0.086***	-0.104***	-0.099***	-0.017***
Decha woreda		0.859***	0.187	0.229***	0.100***	-0.172***	-0.135***	-0.022***
/cut1		-0.326	0.931					
/cut2		0.766	0.928					
/cut3		1.852*	0.931					
/cut4		2.936***	0.936					

Table 23. Determinants of households' perceptions about five major sources of risk (Continued on next page)

Financial Risk Variables	Coef.	Std. Err.	Marginal Effects (dy/dx)				
			Pr(y=5)	Pr(y=4)	Pr(y=3)	Pr(y=2)	Pr(y=1)
Sex(1=Male, 0 =Female)	0.215	0.182	0.040	0.024	0.006	-0.027	-0.043
Age (years)	-0.011	0.007	-0.002	-0.001	0.000	0.001	0.002
Education(1=literate, 0 = illiterate)	-0.181	0.151	-0.036	-0.019	0.000	0.022	0.032
Cooperative membership (1= yes, 0 = no)	-0.251	0.161	-0.058	-0.029	0.005	0.035	0.047
Family size	0.013	0.029	0.003	0.002	0.000	-0.002	-0.003
Training received (1= yes, 0 = no)	-0.138	0.147	-0.030	-0.015	0.002	0.018	0.025
Extension visit (frequency)	0.028	0.031	0.006	0.003	0.000	-0.004	-0.005
Livestock (in TLU units)	-0.040	0.031	-0.009	-0.005	0.000	0.005	0.008
Credit utilization (1= yes, 0 = no)	0.795***	0.126	0.164***	0.085***	0.006***	-0.099***	-0.157***
Mobile ownership (1= yes, 0 = no)	-0.196	0.142	-0.045	-0.023	0.004	0.027	0.037
Log coffee income	0.364	0.292	0.076	0.041	0.000	-0.048	-0.069
Efficiency scores	-0.783	0.556	-0.158	-0.085	0.001	0.100	0.143
Price information at Primary markets (1=yes, 0= no)	0.284*	0.144	0.063*	0.031*	-0.006*	-0.037*	-0.050*
Government agent at primary markets(1=yes, 0= n0)	0.172	0.170	0.035	0.020	0.003	-0.023	-0.035
Follow ECX price (1=yes, 0= no)	0.015	0.141	0.000	0.000	0.000	0.000	0.000
Price change before 5 years(price is higher =1, 0 = otherwise	-0.179	0.129	-0.035	-0.019	-0.001	0.022	0.032
Coffee price volatility compared to cereals	0.375**	0.143	0.066**	0.039**	0.010**	-0.044**	-0.071**
Chena woreda	0.209	0.173	0.044	0.022	-0.003	-0.027	-0.037
Decha woreda	-0.265	0.182	-0.056	-0.033	-0.008	0.037	0.059
/cut1	-0.845	0.913					
/cut2	-0.291	0.914					
/cut3	1.013	0.914					
/cut4	1.488	0.914					

Table 23. Determinants of households' perceptions about five major sources of risk (Continued on next page)

Institutional Risk Variables	Coef.	Std. Err.	Marginal Effects (dy/dx)				
			Pr(y=5)	Pr(y=4)	Pr(y=3)	Pr(y=2)	Pr(y=1)
Sex(1=Male, 0 =Female)	-0.204	0.188	-0.041	-0.014	-0.008	0.016	0.046
Age (years)	-0.009	0.007	-0.002	-0.001	0.000	0.001	0.003
Education(1=literate, 0 = illiterate)	0.633***	0.146	0.115***	0.036***	0.019***	-0.051*	-0.119***
Cooperative membership (1= yes, 0 = no)	0.110	0.163	0.021	0.008	0.005	-0.006	-0.028
Family size (numbers in units)	-0.025	0.030	-0.007	-0.003	-0.002	0.002	0.009
Training received (1= yes, 0 = no)	-0.041	0.151	-0.006	-0.002	-0.001	0.002	0.008
Extension visit (frequency)	-0.021	0.032	-0.005	-0.002	-0.001	0.001	0.006
Livestock (in TLU units)	0.046	0.031	0.010	0.004	0.002	-0.003	-0.013
Credit utilization (1= yes, 0 = no)	-0.330*	0.126	-0.070*	-0.025*	-0.014*	0.022**	0.087***
Mobile ownership (1= yes, 0 = no)	-0.336*	0.146	-0.083*	-0.027*	-0.015*	0.034**	0.092***
Log coffee income	0.477	0.301	0.094	0.034	0.020	-0.028	-0.120
Efficiency scores	0.138	0.575	0.032	0.012	0.007	-0.009	-0.041
Price information at Primary markets (1=yes, 0= no)	0.311*	0.147	0.057*	0.022*	0.013**	-0.011	-0.081**
Government agent at primary markets(1=yes, 0= no)	-0.116	0.175	-0.029	-0.010	-0.006	0.010	0.035
Follow ECX price (1=yes, 0= no)	0.122	0.146	0.029	0.011	0.006	-0.008	-0.038
Price change before 5 years(price is higher =1, 0= otherwise)	-0.213	0.133	-0.052	-0.019	-0.011	0.014	0.069
Coffee price volatility compared to cereals	0.162	0.157	0.036	0.013	0.008	-0.011	-0.046
Chena woreda (1=yes, 0= no)	-0.244	0.178	-0.050	-0.019	-0.011	0.011	0.069
Decha woreda (1=yes, 0= no)	-0.256	0.189	-0.052	-0.020	-0.012	0.009	0.075
/cut1	-0.840	0.943					
/cut2	0.619	0.945					
/cut3	0.817	0.944					
/cut4	1.123	0.943					

Table 23. Determinants of households' perceptions about five major sources of risk (Continued on next page)

Human Related Risk		Coef.	Std. Err.	Marginal Effects(dy/dx)				
Variables				Pr(y=5)	Pr(y=4)	Pr(y=3)	Pr(y=2)	Pr(y=1)
Sex(1=Male, 0 =Female)		-0.009	0.007	-0.001	-0.001	-0.001	-0.001	0.003
Age (years)		0.633***	0.146	0.052***	0.065***	0.055***	0.046***	-0.218***
Education(1=literate, 0 = illiterate)		0.162	0.157	-0.013	-0.019	-0.018	-0.018	0.068
Cooperative membership (1= yes, 0 = no)		0.110	0.163	0.001	0.001	0.001	0.001	-0.004
Family size		-0.025	0.030	0.000	0.000	0.000	0.000	0.000
Training received (1= yes, 0 = no)		-0.041	0.151	0.013	0.020	0.020	0.022	-0.075
Extension visit (frequency)		-0.021	0.032	0.002	0.004	0.003	0.004	-0.013
Livestock (in TLU units)		0.122*	0.146	0.028*	0.039*	0.035*	0.034*	-0.136*
Credit utilization (1= yes, 0 = no)		-0.330	0.126	-0.010	-0.014	-0.014	-0.014	0.052
Mobile ownership (1= yes, 0 = no)		-0.336	0.146	0.005	0.007	0.007	0.007	-0.025
Log coffee income		-0.477*	0.301	-0.058*	-0.085*	-0.080*	-0.083*	0.307*
Efficiency scores		0.138	0.575	0.031	0.046	0.043	0.045	-0.165
Price information at Primary markets (1=yes, 0= no)		0.311	0.147	-0.008	-0.011	-0.010	-0.010	0.040
Government agent at primary markets(1=yes, 0= n0)		-0.116	0.175	-0.023	-0.031	-0.028	-0.025	0.108
Follow ECX price (1=yes, 0= no)		0.046	0.031	-0.002	-0.003	-0.003	-0.003	0.012
Price change before 5 years(price is higher =1, 0= otherwise)		-0.213	0.133	-0.011	-0.017	-0.016	-0.017	0.060
Coffee price volatility compared to cereals		-0.204	0.188	-0.005	-0.007	-0.007	-0.007	0.027
Chena woreda		-0.244	0.178	-0.021	-0.031	-0.031	-0.034	0.117
Decha woreda		-0.256*	0.189	-0.025*	-0.040*	-0.041*	-0.048**	0.154*
/cut1		-3.078**	1.042					
/cut2		-2.444*	1.039					
/cut3		-2.022	1.039					
/cut4		-1.496	1.039					

Table 23. Determinants of households' perceptions about five major sources of risk

Variables	Coef.	Std. Err.
/atanhrho_12	0.070	0.078
/atanhrho_13	0.055	0.080
/atanhrho_14	-0.363***	0.085
/atanhrho_15	-0.292***	0.090
/atanhrho_23	-0.025	0.073
/atanhrho_24	-0.367***	0.065
/atanhrho_25	-0.418***	0.068
/atanhrho_34	-0.568***	0.066
/atanhrho_35	-0.495***	0.067
/atanhrho_45	-0.306***	0.067
rho_12	0.070	0.078
rho_13	0.054	0.079
rho_14	-0.348	0.074
rho_15	-0.284	0.083
rho_23	-0.024	0.063
rho_24	-0.351	0.057
rho_25	-0.395	0.057
rho_34	-0.514	0.049
rho_35	-0.458	0.053
rho_45	-0.297	0.061
Log likelihood =	-1881.63	
LR chi2(95)	557.46	
Prob > chi2	0	

***, ** and * indicate the level of significance at 1, 10 and 5 percent, respectively.

Source: Own computation result based on survey data, 2015

4.3.2.4. Determinants of households' perceptions about institutional risks

In this section, households' farm and socio-economic factors are considered for analyzing the determinants of households' perception about institutional risk (in terms of degree of importance). Factors such as, level of education, credit utilization, mobile ownership, and price information at primary markets are statistically significant and influence household's perception about institutional related risks. Except the level of education and coffee price information at primary markets, the other variables have been found to negatively and significantly determine households' perception about the importance of institutional risks. As indicated in the same Table 23, the multivariate ordered probit model result illustrates that literate households were inclined to perceive institutional risks as the most important source of risk to their coffee business at 1 percent level of significance. The marginal effect result indicates that literate households are 11.5 percentage points more likely perceived institutional risks as the most important but 11.9 percentage points less likely perceived as the least important source of risk, respectively.

Households who received and properly utilized credit for production and maintenance of coffee trees are less likely to perceive institutional risks as the most important source of coffee farm risk at 5 percent level of significance. The marginal effect result of the model showed that households who received and properly utilized credit are 7 and 8.7 percentage points less likely to perceive institutional related risks as the most important ($y=5$), and least important ($y=1$) sources of risk. It has been expected different result regarding the relationship between access to credit and perception to institutional risks. For example, in our previous discussion a positive relation has been found between credit utilization and perceptions about financial risks, which is as we expected. However, a negative relationship is observed between credit utilization and perceptions about the importance of institutional risks; this might be due to the fact that sample households who have had better perceptions about financial risks might perceive institutional risks as the least important source to their coffee production.

Unexpectedly, households' mobile ownership has been found to negatively and significantly determine households' perception about institutional risks at 5 percent levels of significance. This means that households with mobile phones are less likely to perceive institutional risks as the most important source of coffee farm risk. The marginal effect result of the model depicts that mobile

ownership decreases the probability of perceiving institutional risks as the most important ($y=5$) source of risk by 8.3 percentage points. This might be due to the reason that as institutional risks are related to changes in government policies, households' responsiveness might be limited because of bounded rationality (inability to make use of all the available information). On contrary, it has been found a positive and significant relationship between getting price information at primary markets and households perception about institutional risks in terms of the degree of importance. The marginal effect result depicts households who get price information at primary markets are 5.7 percent more likely to perceive institutional risks as the most important source of risk. The same result indicates these households are 8.1 percentage points less likely to perceive institutional risks as the least important source of risk.

The rho values indicated in Table 23 show that household perceptions about institutional risks are negatively and significantly correlated with their perceptions to human related risks. This implies that households that perceive institutional risks as the most important source of risk to their coffee business perceive human related risks as the least important sources of risk.

4.3.2.5. Determinants of households' perceptions to human/personal risks

As shown in Table 23, the multivariate ordered probit model result; households' farm and socio-economic factors were considered for analyzing the determinants of human/personal related risks as an important source of risk. Sample households' perception about human related risks was determined by factors such as age, livestock holding, coffee income and location of sample households.

The result indicates that the age of a household has positively and significantly determined households' perception about human related risks at 1 percent level of significance. This is in conformity with our *priori* expectation. The marginal effect result indicates a one year increment in the age of a household head increases households' probability of perceiving human/personal related risks as the most important source of coffee farm risk by 5.2 percentage points. The same result indicates a one year increment in the age of a household head decreases the probability of perceiving human related risks as the least important source of risk by 21.8 percentage points. In other words, sample households with longer years of age are susceptible to various human diseases and hence they tend to perceive human related risks as the most important source of risk to their coffee production.

Actually, as it is indicated in the descriptive part human/ personal related risks are the least ranked source of risk to coffee production.

The other variable that has negatively and significantly determined households' perception about human related risk is livestock holding. The marginal effect result reveals that each unit increase in TLU decreases the chance of reporting human related risk as the most important source of risk by 5.8 percentage points. In contract, a unit increment in TLU increases the likelihood of reporting human related risks as the least important source of risk by 21.8 percentage points. This is in agreement with a *priori* expectation. As TLU is one indicator of resource for a household, higher TLU indicates a higher wealth and hence, households keep their health better. Consequently, one could claim that the households with better resource base might not perceive human related risks as an important source of risk to their coffee production.

There is also a negative and significant relation between income from coffee and households' perception about human related risks at 5 percent level of significance. A one percent increase in coffee income of a sample household reduces the probability of perceiving human related risk as the most important source of risk 5.8 percentage points. A one percentage increase in coffee increases the probability of perceiving human related risks as the least important source of risk by 30.7 percent. This means that households with higher coffee income are less likely to perceive human related risks as the most important source of risk. But they are more likely to perceive these risks as the least importance source of risk to coffee production. Thus one can say that households who get more coffee income are less likely to perceive human related risks. This implies that households with better coffee incomes are less likely to suffer by accidents, illness, and death which are examples of human related risks that can threaten their coffee farm business.

As can be seen from the same Table 23, households who live in Decha woreda are less likely to perceive human related risks as an important source of risk to their coffee production. The marginal effect result indicates that households living in this woreda are 2.5 percentage points less likely to perceive human related risks. However, these households are 15.4 percentage points more likely to perceive human related risk as the least important source of risk affecting their coffee production. This might be argued that the prevalence of human disease and frequency of death might be less in that specific location compared to other study woredas.

4.3.3. Households' responses about risk management strategies

Managing agricultural risk is particularly important for smallholder farmers, who are usually already vulnerable to different sources of risks and lack the resources to absorb shocks. Typical shocks such as prevalence of pests and disease or a pronounced drop in market prices prevent poor households from acquiring assets or making the most of the assets they have (Cole *et al.*, 2008). They push families into poverty and cause extreme hardship for those already in poverty. Thus, improved management of agricultural risk has significant potential to increase productivity enhancing investments in agriculture (World Bank, 2005). To this end, in terms of relevance to their coffee farm business, we have identified sampled households' responses to 5 major risk management strategies which are crop and livestock diversity, pest and disease management, non-farm employment, information retrieval and use, and market contracts.

As depicted in Table 24, in terms of relevance to their coffee farm business, 77.74 and 70.33 percents of the sampled households selected crop and livestock based diversification as the first and pest & disease management as the second most relevant risk management strategies. And 65.58 and 62.91 percent of sampled households' opt for non-farm employment and market contracts as relevant risk management strategies to their coffee farm business, respectively. About 60.24 percents of sampled household's indicated information retrieval and use as the least used and preferred risk management strategy to their coffee farm business. Moreover, there is no perceived difference in risk management strategies between woredas except for crop and livestock based diversification which is chosen differently at 10 percent level of significance.

Table 24. Sample households' selection and use of risk-management strategies (in percent)

Risk management strategies	Freq.	Total	Sample woredas			χ^2 -test
			Chena	Decha	Gimbo	
Crop and livestock based diversification	262	77.74	70.94	84.27	79.39	5.53**
Pest and Disease management	237	70.33	64.96	74.16	72.52	2.54
Information retrieval and use	203	60.24	57.26	68.54	57.25	3.48
Market contracts	212	62.91	54.70	62.92	68.70	0.14
Non-farm employment	221	65.58	68.38	67.42	61.83	0.71

Source: Own computation result based on survey data, 2015

With respect to the management of the different types of risks, as depicted on Table 28, 14.5, 2 and 17.2 percent of sample households perceive that they fully handled production, institutional, and human/personal related risks on their own farm, respectively. It is noted that for some types of risks the numbers in the row ‘yes I managed the risk partly’ are higher than for other risks. This is for instance the case for production risks (58.5%), financial risks (27.9 %), market risk (31.8%) and human related/personal risks (76.9%). Additionally, sample households perceive that they did not (yet) adequately dealt with institutional risks (95%) (changes in governmental regulations), financial risks (61.7%) related to changes in interest rates and weak credit access, and market risks (51.9%) related to coffee price variability and dependency on coffee buyers.

Table 25. Sample households’ perceptions about the extent to which risks are managed

Risk is self managed	Production Risk		Financial Risk		Market Risk		Institutional Risk		Human Related Risk	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq.	%
No	91	27.0	208	61.7	175	51.9	320	95.0	20	5.9
Yes, partly	197	58.5	94	27.9	107	31.8	10	3.0	259	76.9
Yes	49	14.5	35	10.4	55	16.3	7	2.0	58	17.2
Total	337	100	337	100	337	100	337	100	337	100

Source: Own computation based on survey data, 2015

The result further indicates that there remains a lot to be done towards enhancing the self-insurance capacity of farm households and increase profitability levels.

4.3.3.1. Determinants of households’ perception to risk management strategies

In this section, a multivariate probit regression model results on the determinants of households’ selection and use of risk management strategies are presented. In this model, households’ perception to different sources of risk, households’ farm and socio-economic factors were considered for analyzing the determinants of households’ responses to different types of risks.

The estimated model is highly significant, with a likelihood ratio test of the hypothesis that the coefficients (12 of them) are zero is rejected based on a Wald chi-squared value of 357.01 with 73 degrees of freedom.

As it can be seen from Table 26, the multivariate probit model result show that households' perceptions about the sources of risks do guide selection and use of risk management strategies (namely; pest and disease management, crop and livestock based diversification, information retrieval and use, contract farming, market contracts and non-farm employment). For instance, households who perceived production risk as the most important source of risk are more likely to consider crop and livestock based diversification as a relevant risk management strategy. That means, sampled households that perceive production risk as an important source of risk are 8.7 percent more likely to select and use crop and livestock based diversification as a relevant risk management strategy at 10 % level of significance. This is in conformity with the findings of Pennings and Leuthold (2000) who stated that there is a positive relationship between risk perception and producers' use of risk management strategies. Similarly, many factors may contribute to a farmer's decision to diversify. The underlying theory suggests that farmers are more likely to diversify if they confront greater risks in farming (Hardaker *et al.*, 2004).

As expected, the level of education is a positive and significant factor that determines the probability of using crop and livestock based diversification as a relevant risk management strategy. That means, literate households are 14.2 percent more likely to select crop and livestock based diversification as a relevant risk management strategy at 10 percent level of significance than those households who are illiterate. This implies that more educated households choose crop and livestock based diversification risk management strategy as highly important. This finding is similar to that of Mustafa (2006) who argued that more educated farmers performed better in managing their farm business compared with less educated farmers. The other variable that is positive and significantly related to crop and livestock diversification is the number of trainings received in coffee production and quality maintenance. A one unit increase in the amount of training received would increase the probability to select and consider crop and livestock diversification as a relevant risk management strategy by 16.4 percent.

Management of pest and diseases is a key element in risk management in all sectors, including agriculture. It is not an old fashioned or outdated risk management strategy. Pest and disease management on farm is likely to be an efficient risk management strategy, particularly if farmers are well informed about all their possible choices. To this end, sample households' choice of pest and disease management as a relevant risk management strategy is positively and significantly

determined by factors such as educational status, number of training received in coffee quality and production, and use of improved coffee varieties. For instance, households who are literate more likely use pest and disease management as a vital risk management strategy compared to the counterparts. This means literate households are 30.8 percent more likely to select pest and disease management as a relevant risk management strategy. In other words, being literate would increase the probability of choosing pest and disease management as a relevant risk management strategy by 0.31 points more than illiterate sample households.

Another variable that is positive and significantly related with pest and disease management type of risk management strategy is the use of improved variety of coffee. Sampled households who planted improved varieties of coffee tree such as (74112, 74110, Specialty, Wushwush and Yirgacheffe) are 12 percent more likely to select pest and disease management as a relevant risk management strategy.

Making use of retrieved information by smallholder farmers is an important risk management strategy that assists farmers to reduce or limit the losses of agricultural products that occur due to various reasons. Thus, sample households were asked to tell whether or not the provision of information is relevant to manage different types of risks to which coffee farms are susceptible. Factors such as households' perception of human/personal related and financial risks are found negative and significantly determine households' information retrieval and use as a relevant risk management strategy both at 1 percent level of significance (See Table 29). But, households' perception to marketing risks has been found positive and significant at 10 percent critical level.

First, households who perceive human/personal and financial risks as an important source of risk are less likely to consider information as a pertinent risk management strategy. The marginal effect at the means shows, that such households are 11.9 and 10.2 percent less likely to use information retrieval as a relevant tool to manage risks in that order. Second, households who perceive marketing risk as an important source of risk are more likely to consider information retrieval and use as an important risk management strategy. That is, the marginal effect at the means shows, that such households are 7.9 percent more likely to select information retrieval and use as a relevant tool to manage risks.

Table 26. Determinants of households' selection and use of risk management strategies (Continues)

Variables	Risk Management Strategies								
	Pest & disease mgmt			Crop & livestock based diversification			Retrieval use of information		
	Coef.	Robus t Std. Err.	dy/dx	Coef.	Robust Std. Err.	dy/dx	Coef.	Robu sStd. Err.	dy/dx
Perception about production risk(Likert scale)	0.096	0.122	0.032	0.352**	0.125	0.087	0.010	0.116	0.004
Perception about financial risk(Likert scale)	-0.009	0.083	-0.004	-0.076	0.084	-0.017	-0.267***	0.075	-0.102
Perception about market risk(Likert scale)	0.035	0.087	0.008	0.034	0.088	0.009	0.206**	0.081	0.079
Perception about human related risk(Likert scale)	-0.010	0.092	-0.004	0.059	0.097	0.015	-0.312***	0.086	-0.119
Education(1=literate, 0= illiterate)	1.033**	0.204	0.308	0.559**	0.207	0.142	-0.081	0.179	-0.031
Cooperative membership (1=yes, 0= not)	0.153	0.193	0.047	0.002	0.196	0.005	0.052	0.182	0.020
Training received (frequency)	0.427*	0.185	0.126	0.643***	0.185	0.164	0.161	0.173	0.062
Credit Utilization (1=yes, 0= not)	-0.320	0.181	-0.092	-0.092	0.181	-0.024	-0.185	0.161	-0.071
Mobile ownership (1=yes, 0= not)	-0.092	0.194	-0.022	-0.322	0.201	-0.080	0.095	0.166	0.037
HH size(number)	0.076	0.041	0.023	-0.010	0.041	-0.003	0.000	0.034	0.000
Improved variety (1=yes, 0= not)	0.410*	0.208	0.121	0.242	0.212	0.057	0.156	0.200	0.060
Coffee plot size (in hectares)	0.132	0.108	0.044	0.116	0.108	0.037	-0.002	0.082	-0.001
_cons	-1.318	0.844		-1.241	0.868		0.738	0.780	
rho21	0.10								
rho31	0.18								
rho32	-0.01								
Rho41	0.01								
Rho42	-0.18								
Rho43	0.06								
Rho51	0.04								
Rho52	-0.04								
Rho53	-0.09								
Rho54	-0.09								

Table 26. Determinants of households' selection and use of risk management strategies (Continued from previous page)

Variables	Risk Management Strategies						
	Market contracts				Non-farm employment		
	Coef.	Robust Std. Err.	dy/dx		Coef.	Robust Std. Err.	dy/dx
Perception about production risk(Likert scale)	0.156	0.113	0.059		-0.201	0.118	-0.035
Perception about financial risk(Likert scale)	-0.112	0.077	-0.043		0.041	0.078	0.012
Perception about market risk (Likert scale)	0.409***	0.084	0.157		0.004	0.082	-0.028
Perception about human related risk(Likert scale)	-0.105	0.087	-0.035		-0.007	0.091	0.013
Education(1=literate, 0= iliterate)	0.152	0.186	0.055		0.348***	0.087	0.081
Cooperative membership (1=yes, 0= not)	0.142	0.191	0.051		0.219	0.183	0.077
Training received (frequency)	0.096	0.186	0.042		-0.229	0.185	-0.043
Credit Utilization (1=yes, 0= not)	0.279	0.165	0.111		-0.213	0.165	-0.067
Mobile ownership (1=yes, 0= not)	0.188	0.175	0.067		0.243	0.181	-0.004
HH size(number)	0.037	0.037	0.013		0.011***	0.043	0.095
Improved variety (1=yes, 0= not)	-0.099	0.208	-0.037		0.304	0.202	0.049
Coffee plot size (in hectares)	-0.300***	0.077	-0.113		-0.037	0.088	-0.015
Constant	-1.48*	0.801			0.877	0.816	
Wald chi2(73)	357***						
Prob > chi2	0						
Log pseudo likelihood	-1071.1						
LR test of $\rho_{21} = \rho_{31} = \rho_{41} = \rho_{51} = \rho_{32} = \rho_{42} = \rho_{52} = \rho_{43} = \rho_{53} = \rho_{54} = 0$: chi2(12) = 20.21							

***, ** and * indicate the level of significance at 1, 10 and 5 percent, respectively.

Source: Own computation based on survey data, 2015

In order to mitigate risk, in developed economies, farmers insure their crop or livestock. However, in the study areas, both insurance and credit markets are either imperfect or non-existent. This can leave contracting as a pertinent institutional form to manage risks. Supportive actions to promote contract farming with smallholder coffee growers may appear decisive to reduce mainly production and marketing risks.

The result depicted in Table 26, indicate that factors determining market contracts are related to sample households' perception about market risk and coffee land size. Households' perception about market risk is found to have significant and positive effect except for coffee farm size which is negatively significant. As expected, households' who perceive marketing risk as an important source of risk, are more likely to consider market contracts as a relevant risk management strategy. The marginal effect at the means indicate that households who perceive market risk as important source of risk are 15.7 percent more likely to consider market contracts as a pertinent risk response at 1 percent level of significance than those with less perceptions to this type of risk. This result is in conformity with the works of Anseeuw *et al.* (2012) who argued that market arrangement that will be favored depends on market risks faced by producers and buyers.

Households with smaller coffee land sizes tend to perceive market contracts as an important risk management tool for managing risks. The marginal effect indicates that a unit increase in coffee land size tends to decrease the probability of using market contract as a relevant risk management strategy by 0.11 points. This is due to the fact that larger land size is related to a larger asset base from which to draw resources. In the same vein, Velandia *et al.* (2009) reported that a higher land size signals a larger capacity for bearing risk and a lesser need for risk management instruments.

Regarding non-farm employment as a tool for risk management strategy, only two factors such as household's level of education and household size are found to be positive and significant. Literate households are more likely to choose to involve in non-farm employment and consider it as a relevant risk management response. These relationships may be due to the fact that households who are literate might have the opportunity to engage in non-farm activities to enhance their income. And, they are also willing to adopt such strategies to improve and maintain their income.

The marginal effect model result indicates that literate households are 8.7 percent more likely to opt

for non-farm employment as an important risk management strategy than households who are illiterate at 5 percent level of significance. The next important factor that determines households' choice of non-farm employment as a relevant strategy to manage risk is household size. Households with larger family size are more likely to use non-farm employment as a relevant risk management strategy than those with smaller household sizes. The marginal effect indicates that households with larger household size are 4.3 percent more likely to select and use non-farm employment as a relevant risk management tool.

4.4. Governance Structure Choices of Smallholder Coffee Growers

4.4.1. Households' choice of governance structures

Data collected from 337 households indicate that more than 39 and 31 percent are involved in cooperative type and spot/primary market type governance structures, and 29 percent of the households are involved in a bilateral contract based governance structure scheme. As depicted in Table 27, 52.3, 28.2 and 18.6 percent of households in Chena, Decha and Gimbo woredas engage in spot/primary market type and similarly, 27.6, 36.2 and 50.6 percent of households in Chena, Decha and Gimbo woredas make use of cooperative type of governance structure for transacting their coffee in that order. Moreover, households' choice of cooperative type of governance structure was found to be significantly different between the study Woredas at less than one percent level of significance (see Table 27).

Table 27. Types of governance structures favored by the sample households

Types of governance structures	Sample woredas								χ^2 -test
	Total								
			Chena		Decha		Gimbo		
	Freq.	(%)	Freq.	(%)	Freq.	(%)	Freq.	(%)	
Spot market	185	31.7	91	52.3	53	28.2	41	18.6	2.95
Bilateral contracts	170	29.2	35	20.1	67	35.6	68	30.8	2.31
Cooperatives	228	39.1	48	27.6	68	36.2	112	50.6	13.59***
Total	583	100	174	100	188	100	221	100	

Source: Own computation result based on survey data, 2015

Table 28 summarizes the number of governance structure in which a single sample household had involved. Most of the respondents (45%) are involved in only one type of governance structure. But, about 36 and 18 percent of the sample households are involved in two and three types of governance structures in that order. These categories of sample households who have involved in multi-governance structures did simultaneously select at least two types of governance structures. Sample households who are exclusively choosing only one type of governance structure are considered as having zero degree of multi-governance. As a single household can get involve in one or more types of governance structures, hinting that the smallholder household has an option of transacting in more than one exchange relationship.

Table 28. Number of governance structure in which a household is involved

Degree of multi -governance	Freq.	Percentage (%)	Std. Err.	[95% Conf. Interval]	
Households with 1 type of GS	153	45.4	0.027	0.401	0.508
Households with 2 types of GS	122	36.2	0.026	0.312	0.415
Households with 3 types of GS	62	18.4	0.021	0.146	0.229
Total	337	100.0			

Source: Own computation based on survey data, 2015

Key informants and focus group discussants have delineated the main reason for selecting multi-governance structure is to safeguard their investment, take advantage of minimizing different sources of risks and avoid post-harvest losses of the coffee beans.

Table 29. Relationships between the number of governance structures and coffee land size

Coffee land size	Total number of GS in which a household is involved			
	1	2	3	Total
Small (<1 ha)	103(67.32)	84(68.85)	27(43.55)	214(63.5)
Medium (1-5 ha)	46(30.07)	34(27.87)	29(46.77)	109 (32.34)
large (>5 ha)	4(2.61)	4(10.66)	6(9.68)	14(4.15)
Total	153(100)	122(100)	62(100)	337(100)

Pearson chi2 (4) = 15.43 Pr = 0.004. (..) Column percentage in brackets

Source: Own computation result based on survey data, 2015

Table 29 presents a distribution of sampled household's response with respect to their coffee land sizes and the number of governance structures in which they are involved. It is understood that 67, 30 and 2.6 percents of the sample households who are involved in one type of governance structure produce coffee on small land size, medium (1 to 5 ha) and large land size (> 5ha), respectively. While 69, 28, and 11 percents of households with two types of governance structure are producing coffee on small, medium and large coffee farm sizes, respectively. It can also be argued that the majorities (47 percent) of smallholder coffee producing households who are involved in three types of governance structures do produce coffee on medium land sizes whereas the remaining 43.5 and 9.7 percent of the households do produce coffee on small and large land sizes, respectively.

The computed Pearson Chi² at four (4) degree of freedom, to test the differences between smallholder households' categories, shows that there is a significant difference between the three (3) categories of households considering their coffee land size at 5 % level of significance. Smallholder coffee growers with low production potentials in terms of coffee land size under coffee production are most likely engaged in one or two types of governance structures simultaneously in coffee supply chain.

4.4.2. Determinants of governance structure choices

In order to investigate factors determining sample households' choice of governance structures, Trivariate probit regression using GHK simulated maximum likelihood estimation was used (Table 30).

Wald test is used to examine whether any of the parameters of the model that currently have nonzero values could be set to zero without any statistically significant loss in the model's overall fit to the data ($\beta_{1i}=\beta_{2i}=\beta_{3i}=\dots=0$). It tests the overall significance of the variables included in the econometric model (Ryan and Watson, 2009). Results show that the Wald Chi² is statically significant at 1 percent level, which indicates that the subset of coefficients of the model are jointly significant and that the explanatory power of the factors included in the model is satisfactory.

To test the null hypothesis that correlation matrix is compound symmetric (all correlations are equal), we calculated Lawley chi². The value of Lawley chi² was found to be [Lawley chi² (135) = 1467.81]. Thus, the null hypothesis that all correlations are equal was rejected with (p= 0.000). Moreover,

[Hotelling $T^2 = 56183.02$; Hotelling $F(15,228) = 3354.68$ is significant; implying that the null hypothesis that all means are the same is rejected with $[\text{Prob} > F = 0.000]$. The Likelihood ratio test is also significant; implying that the null hypotheses of all the ρ (Rho) values are jointly equal to zero is rejected. Basically, the p -values explain the degree of correlation between each pair of the dependent variable levels (each type of governance structure choice).

Individually considered, we found two p -values statistically significant (see Table 30). The ρ_{31} (correlation between the cooperative governance structure and the spot/primary market) are positively correlated at 10 percent ($P < 0.1$) level of significance and the ρ_{32} (correlation between cooperative and the bilateral based governance structure) are negatively correlated and at 10 percent critical level. It implied that households involved in the cooperative governance structure are more likely to be involved in spot market type of governance choice as well; and on the contrary, households who are involved in cooperative governance structure are less likely to involve in bilateral contract based type of governance structure and vice versa.

Table 30. Determinants of governance structure choices (Trivariate probit, GHK simulator, 25 draws)

Variables	Governance Structure Choices					
	Spot/primary market		Bilateral contract		Cooperatives	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Human asset specificity (index variable)	-1.315***	0.230	0.603**	0.195	-0.452*	0.230
Uncertainty (index about uncertainty of coffee quality, price & quantity)	-0.580**	0.219	0.439*	0.199	0.489*	0.210
Connectedness(index about buyers quality, & price requirement)	0.070	0.192	1.217***	0.185	0.709***	0.196
Trust (a HH trusts a buyer=1, 0= not)	-0.577**	0.191	0.853***	0.185	0.500*	0.211
Communication(seeks information before sale=1, 0= otherwise)	0.450*	0.189	0.225	0.171	-0.152	0.204
Experience(years)	-0.009	0.010	-0.009	0.009	0.019	0.011
HH size (numbers)	-0.054	0.041	-0.016	0.038	0.091*	0.043
Education(1= literate, 0= illiterate)	0.673**	0.215	-0.093	0.193	0.341	0.232
Training received (frequency)	0.078	0.044	0.011	0.040	-0.019	0.047
Perceived coffee quality (Index variable)	-0.333	0.186	-0.092	0.176	0.936***	0.206
Coffee to total land ratio(hectares)	-1.023*	0.447	-0.746	0.413	0.097	0.485
Log coffee income	-0.417	0.431	0.403	0.403	0.054	0.424
Efficiency score	-1.395**	0.770	-1.760*	0.753	2.905***	0.806
Chena woreda	0.743**	0.243	-0.397	0.230	-0.842**	0.287
Decha woreda	0.424**	0.129	0.423***	0.121	-0.032	0.152
Constant	4.259**	1.318	-1.079	1.198	-3.612**	1.305
ρ_{21}			-0.22			
ρ_{31}			0.38**			
ρ_{32}			-0.99**			
wald chi2(45)			302.41***			
Log likelihood			-415.1			
LR test of $\rho_{21} = \rho_{31} = \rho_{32} = 0$: chi2(3) =			34.24***			

***, ** and * indicate the level of significance at 1, 5 and 10 percent, respectively.

Source: Own computation result based on survey data, 2015

A closer look into results presented in Table 30, allows to understand the various factors affecting the choices of each type of governance structure. First, the human asset specificity is significantly and negatively correlated with the spot/primary market governance structure at 1 percent critical level. This shows that there is no specific investment made in the transaction under market governance for building relations with different buyers. This result is in line with the transaction cost theory stating that the lower the human asset specificity, the more likely the actors are involved in less constraining and less integrated types of transaction arrangement choices (spot/primary market type of governance structure).

Also the human asset specificity is found to be significantly and positively correlated with bilateral contract based type of governance structure at 10 percent critical level. This implies that the choice of bilateral contract based governance structure, where households preferably choose their buyers based on social relationships (familial and/or friendship) and on both (formal and/or informal) contractual relationships, is determined by the farmers' ability to invest in capacity building activities. This may be justified by the existence of high degree of trust between the parties involved in coffee transactions under this type of governance structure. However, human asset specificity is found to be significantly and negatively correlated with cooperative type of governance structure at 5 percent critical level. This is not in agreement with a *priori* hypothesis in which positive relation is expected with cooperative type of governance structure. The cause might be the fact that sample households who are cooperative members do not observe the expenses they incur for building relations to other members within the cooperative.

The transaction connectedness refers to how transactions differ in how they are connected to other transactions in the chain. Milgrom and Roberts (1992) argued that when the transactions have a strong connection, strong coordination governance is favorable. A positive and statistically significant correlation was found between the transaction connectedness and bilateral contract and cooperative type of governance structures both at 1 percent level of significance. The transaction connectedness has been measured by the farmers' awareness of the demand attributes of the first hand customers, which can be a trader, a collector, a processing company or an exporter. The transaction connectedness also considers second hand buyer's demand attributes and quality requirements. From this result, one can safely conclude that the more households are engaged in a

highly coordinated type of governance structure, the more likely they are aware of the end consumer's quality requirements, and the more they adjust production practices to fulfill the demand. It can also be said that, if the governance structure in coffee transactions is more hierarchical, then one could expect a positive correlation with transaction connectedness.

One positive and favorable indicator for choosing bilateral contracts and cooperative type of governance structures is the uncertain behavior of households about the stability of coffee quantities, prices and quality. This factor is positively and significantly correlated with bilateral contracts and cooperative choices both at 5 percent and negatively with spot market at 10 percent level of significance. The implication is that households who have uncertain behavior about the stability of coffee quantities, prices and quality are more likely to involve in cooperative and bilateral contract and less likely in spot market types of governance structures in the study areas.

It is observed that the public and private sectors are most likely to support cooperatives and bilateral contracts, rather than spot market type of governance structures. Also, the national policies and strategies of agricultural development give more priority in assisting collective actions (associations, cooperatives) than individuals. Moreover, in conformity with the above statement, the model result pointed out that the higher the perceived quality of coffee, the more likely that smallholder household participates in cooperative type of GS at 1 percent level of significance. From these result, one can claim that households who produce quality coffee are willing to sell their coffee produce to cooperatives than at primary markets. In other words, households who do produce quality coffee are less likely willing to transact their coffee to a spot market type of governance structure.

The other institutional factor which was considered in this analysis is the degree of trust between the transacting parties i.e. smallholder households and buyers. It was previously demonstrated that the spot/primary market governance structure is characterized by less human specific investment while the bilateral contract based governance structure is characterized by a high human specific investment in capacity building. Considering trust as an institutional variable, the finding shows that there exists a significant and positive relationship between the degree of trust and the choice of bilateral contracts and cooperative based types of governance structures between smallholder households and buyers involved in the transaction of coffee at 1 and 5 percent critical levels, respectively. Contrary to this,

as hypothesized, there is a negative and significant correlation between trust and the spot market based governance structure at 10 percent level of significance. This indicates that households who do not trust their buyers are not likely to choose spot market type of transaction arrangement along the coffee supply chain in the study areas.

Market attributes were also considered in assessing the household's choice of governance structures. Among the different indicators used to measure the market attributes is households' request for information about coffee prices from different buyers before selling their produce. The trivariate probit model result (Table 30) shows a significant relationship between households who do seek price information and spot market type of governance structure. There exists a positive and significant relationship between farmers who communicate with different buyers to seek price information before sale and the spot market type of governance structure at 1 percent level of significance. This is because households involving in bilateral contracts and cooperatives do have a pre-defined market arrangement and such households mainly do not inquire to communicate with different buyers before sale. This is in line with the hypothesis that proposes, when more pre-agreements exist in market arrangements, farmers are more likely to go for an integrated type of governance structure to safeguard their investments (Williamson, 1985).

Findings show that within a spot market type of transaction arrangement, the quantity and price can be agreed at the moment and the place where the transaction takes place. It is important to note that in the coffee supply chain, under a spot market arrangement, the market agreements are generally informal (oral) without any written and formal engagement. The drawback of this informal arrangement is that the agreed transaction can unexpectedly be changed at any moment of the transaction, which generally is not the case within cooperative and bilateral contract types of governance structures.

As a control variable, the farmers and the farm characteristics have been included in the trivariate probit model. Results show that there is a negative and significant relationship between coffee land size to total land ratio and the spot market type of governance structure at 5 percent level of significance. This indicates that sample households involved in spot market transactions are those having less hectares of coffee land size to total agricultural land. It has been learnt from the

regression model results that households under spot market arrangement devote less of their land to coffee production as compared to other categories of governance structures.

Other control variables include, household size, their education status (literate or not), and the technical efficiency score of each sampled household. As presented in Table 30, among these factors, household size is shown to be positive and significant at 5 percent critical levels for the cooperative types of governance structure. This implies that the more the size of a household, more likely they participate in cooperative based type of governance structure. In other words, the more the size of households, the more likely they transact in cooperative type of governance structure.

Regarding the relationship about the educational status and governance structure choices of sample households, there exists a positive and significant correlation between educational status and the spot/primary market form of GS at 10 % level of significance. This indicates that literate coffee producers are more likely to choose spot/primary market form of governance structure than illiterate ones. This is in contradiction with our expectation that literate coffee farmers will participate in cooperative governance structures to take advantage of the different institutional supports delivered to cooperatives. However, the reason literate coffee producers' choose spot market type of governance structure might be due to the need to acquire cash immediately after sale (to get rid-off asset hold-up problems) and invest in other productive activities.

Another construct that was considered in explaining the households' choice of governance structure is the location of sample households. In this regard, households who live in Chena woreda transact their coffee produce more likely at spot/primary markets and less likely in cooperative type of governance structures at 10 percent level of significance. Sample households of Decha woreda, simultaneously participate both at spot/primary markets and in bilateral type of governance structures.

One of the most novel result of the present study is about the relationship between technical efficiency score of smallholder coffee growers and their choice of governance structure. As shown in Table 30, there is a negative correlation between technical efficiency scores and spot market and bilateral contract types of governance structure. Nevertheless, a positive correlation is observed between technical efficiency scores and cooperative type of governance structure at 1 percent level of

significance. Based on the results, it can be argued that technically efficient smallholder coffee growers do less likely participate in spot market and bilateral contract based type of transactions, but more likely participate in cooperative type of governance structure. Conversely, the parameters such as frequency of training, experience in coffee production, distance to coffee plots, and income from coffee are not statistically different from zero.

4.5. Challenges in Coffee Transactions

The following challenges of coffee transactions are identified during the focus group discussion and key informant interviews.

a. Transacting coffee out of transaction centers

According to Article 6(1) of the Coffee Quality Control and Marketing Proclamation (CQCMP) No. 602/2008, any person involved in coffee transaction shall conduct coffee transaction only in transaction centers. However, the reality on the ground is quite different. Key informants from government side mentioned that the proclamation was issued to make coffee marketing system fast, cost effective and enable coffee producers earn income from coffee transactions. But due to inefficient marketing system, loose government monitoring and control, there exists illegal smuggling of coffee to different areas. And most of the interviewed coffee suppliers voiced that they are unable to compete with illegal coffee suppliers (sebsabies) because the illegal coffee suppliers do not pay tax and hence pay higher prices for a kilo of red or dry cherry coffee than the amount legal coffee suppliers pay to smallholder coffee producers in the primary markets. During the discussions, participants raised a question regarding property right issue about their own coffee saying that “*To whom does our coffee belong? To the government or producer or trader?*” indicating the proclamation forces them to sell their product in transaction centers as it is prohibited to sell or buy coffee outside ECX or a transaction center established by the Ministry or a concerned regional body. They further indicated that storing coffee by any person for more than one production season is prohibited.

b. Poor quality, less availability and high price of standard coffee bags

When buying and selling coffee, it has to be supplied in sacks. It is useful to know the standard sack weights and its cost. However, it was indicated during the FGD that the availability of standard coffee sacks is limited. Moreover, due to the high price of standard sacks, actors in the supply chain usually use poor quality sacks with implications on the coffee prices they receive.

c. Supply of poor quality coffee and low volume of transactions

A key informant interview with officers of ECX and cooperative union leaders has allowed to learn that the quality of coffee supplied by local coffee collectors is not up to the standard. Moreover, it was hinted that sometimes coffee supplies which are expected to be of high standard are awarded lower grades and at the same time coffee supplies that are considered of inferior quality are considered of higher standards. This has confused many local officials and actors in the coffee supply chain in the study areas. They said that it is difficult to build a trust on the grading practices of coffee by ECX. Additionally, it was also indicated that annual coffee production forecast of the Kefa Zone Agricultural office and the zonal coffee supply to ECX has a big difference. The discussants agreed that the main reason for the difference is due to illegal coffee trading to neighboring areas and cross-border to Kenya.

d. Limited availability of coffee washing and/ or processing plants

During the FGD and key informant interviews, the discussants and interviewees pointed out that only a small number of coffee washing and processing plants exist nearby smallholder coffee producers in the study areas. As a result, coffee growers are obliged to go far distances to sell their produce and hence they incur higher transaction costs.

e. Presence of very few coffee suppliers at primary transaction centers

The survey result indicates that on average 3-7 coffee suppliers (Akrabies) are found at each primary market. Key informant interviewees and focus group discussants also indicated that the presence of few coffee suppliers at primary markets has affected the bargaining power of smallholder farmers and hence forced them to transact their coffee at lower prices. This further implies that the market structure at primary coffee resembles like a cartel type of oligopoly, in which few coffee suppliers act

like a monopolist and fix prices together. Due to these and other reasons smallholder coffee growers are usually used to sell their coffee produce to illegal traders.

f. Lack of adequate access to finance by cooperatives

During focus group discussions and key informant interviews, it has been understood that a significant number of coffee growers remain outside unions and even outside cooperatives. But the cooperative unions themselves and officials working in government cooperative offices complain that they are challenged with lack of finance and inadequate access to risk management services, low levels of production and productivity, limited agro-entrepreneurship skills and inadequate organizational and management skills at primary cooperative level.

5. SUMMARY, CONCLUSION AND RECOMMENDATIONS

This chapter summarizes the major findings and draws some important conclusions from the empirical results of the study. Consequently, based on the implications of major findings, some recommendations are suggested to advance the technical efficiency of coffee production, preferences of risk management responses, and governance structure choices for research and agricultural institutions, development planners, NGOs and the farming community. In addition, directions for future research are also suggested.

5.1. Summary and conclusion

Ethiopia is the center of origin and diversity of coffee. Coffee plays a crucial role in the socio-economy of the country. It employs more than 25 percent of the economically active population and contributes more than 31 percent of the country's foreign exchange earnings. The main objective of this study is to measure the technical efficiency of smallholder coffee growers and identify the determinants of technical inefficiency, risk perceptions to sources of risks, risk management responses and governance structure choices.

The data for this study were based primarily on cross-sectional data obtained from a sample of 337 smallholder coffee growers, selected using multistage stratified simple random sampling technique. Moreover, primary and secondary data were also collected from traders, government officers and other actors who do have direct relations to the coffee sector using key informant interviews and FGDs. To measure the overall technical efficiency and identify the determinants of technical inefficiency, parametric stochastic frontier analysis and Tobit model was used. Additionally, multivariate ordered probit, multivariate probit, and trivariate probit econometric models were used to identify determinants of smallholder growers' risk perceptions, risk management strategies and governance structure choices, respectively.

The sample comprised of more males than females. Out of the total number of 337 sample households, 85 percent are male-headed and the average household size is six. The average age of a sample household is about 45 years with a slight variation among sample woredas. Education levels of sample households are low. The Average annual coffee income of a sample household for the year

2014/15 was 12,185 birr. On average, compared to an overall annual agricultural income of 19,439 birr, coffee income comprises 62.7 percent of the total agricultural income. This shows that coffee production is a prime source of livelihood income in the study area.

On average, a household owns 2.37 hectares of land which is more than double of the national average landholding of a household. Of the total hectares of land that is owned by a household, 53 percent (1.22 ha) of the total landholding is under coffee production. Concerning coffee management practices and the use of modern inputs, more than half (58.75 percent) of sample households use improved varieties of coffee. However, the use of chemical inputs such as fertilizers, herbicides and fungicides in coffee production is nonexistent in the study areas. On average, in the last three years 44.5, 55.79 and 58.75 percents of sample households do practice intercropping of coffee with other agricultural crops, mulching and pruning, respectively. Regarding the type of coffee harvesting, the majority (61.7 percent) responded that they use selective harvesting of coffee berries. The remaining 21.7 and 16.6 percents of the surveyed households indicated that they use strip harvesting and both methods (strip and selective harvesting), respectively. This indicates that still significant number of coffee growers use strip harvesting and hence have negligible effect on the quality of coffee.

The mean coffee yield (dry parchment coffee) across the sample households was 734.82 kg per hectare. But, there exists a big difference in coffee production among the sampled. The study reveals that the technical efficiency (TE) of sample households ranges from 15 percent to 94 percent, with mean technical efficiency of 64 percent using half-normal distributional assumption of inefficiency. This study also indicates that education, pruning, use of improved variety; cooperative membership, mobile ownership, and proper utilization of credit are important determinants that increase the technical efficiency of coffee growers in the study areas. On the other hand, intercropping, age of coffee tree and coffee plot number are determinants that would decrease the technical efficiency of smallholder coffee growers. Thus, the finding of the study reveals the existence of technical inefficiency among smallholder coffee growers in the study areas. The coffee plot number-inefficiency relationship is positive indicating households with more coffee plots are less technically efficient than households with lesser coffee plots as expected.

In terms of importance to their coffee farm business, sampled households' perceived production and

market risks as the first and the second most important perceived source of risk affecting their coffee production. Financial, institutional and human related risks were perceived and ranked as the third, fourth and fifth sources of risk affecting their coffee farm business, respectively.

This study further reveals that household's characteristics, socio-economic factors, institutional factors, coffee production practices, technical efficiency levels, physical locations and use of technology determines household's perception to various sources of risks. Technically efficient farmers perceive more likely production risks but less likely financial risks as the most important sources of risk. In turn, households' perception to sources of risks, educational status, membership in cooperatives, and use of improved varieties determine household's preference and selection of risk management strategies. Like the findings of other scholars, this study supports the statement that risk perception study cannot be explained by one single theoretical framework, suggesting the importance of using multiple theoretical aspects for better understanding and analysis of risk perceptions and risk management responses.

Relating to the determinants of households response about risk management strategies, households perception about production risks, level of education and frequency of training received were found positive and significantly determine the households' choice and selection of crop and livestock based diversification as a relevant risk management strategy. Factors such as improved variety, educational status and frequency of training received significantly and positively determined households' preference and selection of pest and disease management type of risk management strategy. Households' choice of information retrieval and use as a relevant risk management strategy was positively determined by their perceptions of market risks, and negatively by their perceptions of financial and human related risks. Moreover, households' choice of market contracts as a pertinent risk management strategy was positively determined by their perceptions about market risks and negatively by coffee plot size. The choice of non- farm employment as an essential risk management strategy was positively and significantly determined by household's level of education and household size.

With regard to governance structure choices, the study further reveals that more than 68 and 55 percents of the sample households are involved in cooperative and spot/primary market type of

governance structures and 50% are involved in a bilateral contract based type of governance structure. The parameter estimate of Trivariate Probit model indicated human asset specificity, trust, uncertainty, coffee land to total land ratio, and technical efficiency scores are factors that are significantly and negatively affecting households' choice of spot/primary market type of governance structure. But educational status and location of households are the factors that have been positively and significantly correlated with spot/primary market type of governance structure. The same model result indicated human asset specificity, connectedness of transactions, uncertainty, and location of households' are factors that are significant and positively affect households' choice of bilateral contract type of governance structures. But, technical efficiency score is negatively and significantly affect households' choice of bilateral contract type of governance structure.

Similarly, the same model result revealed that uncertainty of coffee prices, trust, connectedness of transactions, HH size, perceived coffee quality and technical efficiency scores are factors that are significant and positively affect smallholder coffee farmers' choice of cooperative type of governance structures. However, unexpectedly, human asset specificity and location of households (Chena worda) are negatively affecting cooperative type of governance structure.

Smallholder coffee growers' choice of governance structure is in line with the transaction cost theory stating that the higher the value of transaction attributes and institutional factors, the more likely the households' are involved in more constraining and more integrated governance structures i.e. in cooperative and bilateral contract types of governance structures. The result implies that smallholder coffee farmers involved in the cooperative type of governance structure are also more likely to be involved in primary market type of governance choice and vice versa. On the contrary, households who are involved in cooperative type of governance structure are less likely to involve in bilateral contract based type of governance structure and vice versa.

5.2. Recommendations

In order to improve the technical efficiency of the smallholder coffee growers, enhancing households knowledge of coffee production and their growing practices is quite important. The most focus areas for improvements are on crop productivity through higher levels of coffee management practices. This study recommends the use of disease and pest-resistant Arabica coffee varieties, and

pruning management practices. And hence, the regional and local governments, NGO's, and other actors in the study areas should improve the educational status of smallholder coffee growers via adult education or in any form of training about modern way of cultivating coffee and maintaining the quality of coffee. Thus, to improve smallholder coffee growers' technical efficiency, this study suggests that microfinance institutions and other government institutions that give loans should be strengthened, so that they monitor whether loans are utilized for the intended purposes. Additionally, in order to minimize loan shortage of cooperatives, financial institutions are supposed to expand and enlarge the amount of loans provided to the agricultural sector particularly to coffee cooperatives and smallholder coffee growers. Moreover, to improve the technical efficiency of coffee production, this study further advises that government and other stakeholders should promote smallholder coffee growers to become members of cooperatives and use mobile phones for sharing information.

The results of this study further call attention to policy measures that can decrease the number of coffee plots in reducing technical inefficiency due to the positive relationship with inefficiency effects. Thus, by and large, on the basis of the findings of the present study, to increase the level of technical efficiency, this study suggests that government and NGOs working in the study area, should enhance the awareness level of smallholder coffee growers about proper use and management of inputs for coffee production. However, it needs to be noted that, this study is not without limitations. As coffee is a perennial crop where harvesting takes place 4 or 5 years after the tree is planted and due to volatility of wages, allocative and economic efficiencies were not carried out. Even if, reliance on technical efficiency alone has a positive impact on yields and quality, it turns out to be insufficient for guaranteeing long-term welfare gains to smallholder coffee growers. In this regard, to formulate a more comprehensive and informative policies in the coffee sector, further research efforts should then be oriented towards measuring allocative and economic efficiencies, post-harvest losses, and effects of climate change on coffee productivity.

Awareness about smallholder coffee growers' perception to sources of risk, its determinants and choices about their preferences of risk management strategies is essential for creating policy instruments to support the risk management in coffee sector and for the development of training programs tailored to the needs of the smallholder coffee growers. As shown in the analysis, it can be said that perceptions to sources of risks help determine the risk management responses of smallholder

coffee growers in the study area. Thus, this study suggests that when designing risk management strategies the actors should take into consider smallholder coffee growers' perception to sources as they determine their responses to risk management strategies.

Smallholder coffee growers in the study areas need to acquire more professional skills, not only in basic production but also in farm management. In order to succeed, smallholder coffee growers need to generate more profit and become competitive. They ought to have a good understanding of the farming environment and be skilled at managing sources of coffee farm risks. By dealing with risk more effectively, better farming opportunities arise. Extension workers can also help farmers improve their risk management skills. They should help growers recognize and understand their problems and assist them in making better risk management decisions. And hence government policies should take a holistic approach to risk management, assessing all risks and their relationship to each other, and avoiding focusing on a single source of risk such as prices. Government should provide information and training to smallholder coffee growers to evaluate and manage perceived sources of risk. This study also urge that it is time for insurance companies to look for ways of addressing the risks that the smallholder coffee growers are actually facing. Thus, this study suggests insurance companies to promote and deliver crop insurance to smallholder coffee growers at reasonable premiums.

The low coffee price expectation of sample households might also lead to the ignorance of coffee production as they may switch to other more profitable agricultural crops. As a result, there may be a concern that the low coffee price expectations could negatively affect the supply of quality coffee beans and could have adverse effects on household incomes. Replanting of newly improved varieties of coffee trees is particularly important as part of mitigating the impact of different weather shocks and to respond to increased pests and diseases which could adversely affect smallholder coffee growers' production. Generally, besides boosting the technical efficiency of smallholder coffee producers, the coffee industry needs to undertake proactive measures to manage farmers perceived sources of risks such as production, marketing, financial, legal and human related risks. Hence, specific polices need to be formulated to address the issue of economic sustainability of coffee production, stabilizing supply in the future and enabling farmers to be fairly remunerated. Moreover, the specific polices should address primarily production and marketing risks as they are the most perceived sources of agricultural risks for smallholder coffee growers. Thus, this study specifically

suggests that all stakeholders involved in coffee sector should advocate crop and livestock based diversification risk management strategy to handle production risks, information retrieval & use and market contracts to handle market risks, respectively

The transaction cost economy provides many insights into the choice of governance structure, suggesting that everything remaining constant, the rational household will chose a governance structure that is best performing in minimizing the uncertainty and risk that exist during transactions. This study provides empirical evidence to the transaction cost theory and a one step further in the Williamson's attributes of transaction by emphasizing smallholder coffee grower's level of technical efficiency as a determinant attribute that worth consideration in analyzing the choice of the governance structure in less developed countries like Ethiopia.

With regard to the choice of each type of governance structure, results can be used as powerful tool in defining intervention strategies in promoting the contract enforcement in bilateral or cooperative type of GSs in commodity supply chains. Thus, this study suggests that creating awareness to smallholder coffee growers by all stakeholders about the significance of cooperatives is essential for improving household's level of technical efficiency.

Although the study found evidence about the determinants of governance structure choices of smallholder coffee growers within the study area, from the data collected it was not possible to determine the impact of the choices of governance structures on smallholder coffee growers' welfare. Further studies are therefore necessary to determine the effects of governance structures on welfare and food security level of smallholder coffee growers.

Consequently, knowing smallholder coffee growers' level of technical inefficiency in coffee production, perception to sources of risk and responses to risk management strategies and choices of governance structures is of vital importance for synthesizing and dissemination of relevant information to improve TE, handle perceived sources of risks and suggest better risk management strategies to smallholder coffee growers in the study area.

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7. APPENDICES

APPENDIX 7.1

Appendix Table 1: Sampled households level of education by gender

level of education	Unit	Sex		Total
		women	men	
Illiterate	no.	44	127	171
	% column	25.73	74.27	100
	% cell	13.06	37.69	50.74
Primary education	no.	6	138	144
	% column	4.17	95.83	100
	% cell	1.78	40.95	42.73
Secondary education	no.	1	21	22
	% column	4.55	95.45	100
	% cell	0.3	6.23	6.53
Total		51	286	337

Source: Own computation based on survey data, 2015

Appendix Table 2: Kefa zone coffee production estimate under four systems for the year 2013 and 2014

Items	Garden coffee		Forest coffee		Semi-forest coffee		Plantation coffee		Total
	2013	2014	2013	2014	2013	2014	2013	2014	2015
Total area under coffee in ha	61,919	88,072	53558	53558	50570	50570	8554	13154	233,202
Area under productive coffee trees in ha	16,156	27,433	53558	53558	50570	50570	8554	10671	154333
Total production in Qt	120,287	272,048	153511	158,213	194,718	201,770	60676	108,430	804,081
Productivity in Qt/ha	7.45	9.92	2.87	2.95	3.85	3.99	7.10	10.16	5.21

Source: Own computation of data taken from Kefa zone, department of agriculture, 2015/16

Appendix Table 3: Coffee production estimate of Kefa zone for the year 2015

Items	Garden coffee		Forest coffee		Semi-forest		Plantation		Total
	quantity	%	quantity	%	quantity	%	quantity	%	
Total area under coffee in ha	115920	49.71	53558	22.97	50570	21.69	13154	5.64	233202
Area of land under productive trees in ha	38288	24.81	53558	34.70	50570	32.77	13154	8.52	154333
Total Production in Qt	349804	43.50	147581	18.35	185049	23.01	121647	15.13	804081
Productivity in Qt/ha	9.13			2.76	3.66		10.21		5.21

Source: Own computation of data taken from Kefa zone, department of agriculture, 2015/16

Appendix Table 4: Sample household's ranking of the major perceived sources of risk

HH responses to sources of risk 5= very important; 1= not important	Production risk		Financial risk		Market risk		Institutional risk		Human related risk	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
5	132	39.17	53	15.73	70	20.7	56	16.62	23	6.82
4	152	45.1	43	12.76	105	31.6	25	7.42	21	6.23
3	49	14.54	147	43.62	94	27.8	17	5.04	26	7.72
2	2	0.59	52	15.43	55	16.3	162	48.07	67	19.88
1	2	0.59	42	12.46	13	3.8	77	22.85	200	59.35
Total	337	100	37	100	337	100	337	100	337	100

Source: Own computation based on survey data, 2015

Appendix Table 5: Predicted probabilities of the importance of production risk

Production risk					
Variable	Obs	Mean	Std. Dev.	Min	Max
p1oprobit	337	0.392	0.356	2.87E-05	9.94E-01
p2oprobit	337	0.454	0.251	5.99E-03	7.84E-01
p3oprobit	337	0.140	0.189	3.07E-07	6.20E-01
p4oprobit	337	0.006	0.015	6.34E-12	1.06E-01
p5oprobit	337	0.009	0.029	9.94E-13	3.09E-01

Source: Own computation based on survey data, 2015

Appendix Table 6: Predicted probabilities of the importance of marketing risk

Marketing risk					
Variable	Obs	Mean	Std. Dev.	Min	Max
p1oprobit	337	0.205	0.187	0.000	0.829
p2oprobit	337	0.322	0.157	0.004	0.463
p3oprobit	337	0.274	0.127	0.014	0.475
p4oprobit	337	0.157	0.187	0.000	0.536
p5oprobit	337	0.042	0.090	0.000	0.482

Source: Own computation based on survey data, 2015

Appendix Table 7: Predicted probabilities of the importance of financial risks

Variable	Obs	Mean	Std. Dev.	Min	Max
p1oprobit	337	0.156	0.128	0.005	0.617
p2oprobit	337	0.135	0.053	0.016	0.210
p3oprobit	337	0.435	0.063	0.187	0.491
p4oprobit	337	0.147	0.064	0.013	0.240
p5oprobit	337	0.127	0.102	0.003	0.543

Source: Own computation based on survey data, 2015

Appendix Table 8: Predicted probabilities of the importance of institutional risk

Variable	Obs	Mean	Std. Dev.	Min	Max
p1oprobit	337	0.164	0.146	0.004	0.701
p2oprobit	337	0.078	0.034	0.006	0.132
p3oprobit	337	0.054	0.018	0.006	0.077
p4oprobit	337	0.476	0.088	0.141	0.544
p5oprobit	337	0.228	0.154	0.005	0.745

Source: Own computation based on survey data, 2015

Appendix Table 9: Summary of predicted probabilities of the importance of human risk

Variable	Obs	Mean	Std. Dev.	Min	Max
p1oprobit	337	0.066	0.062	0.000	0.425
p2oprobit	337	0.063	0.036	0.001	0.166
p3oprobit	337	0.082	0.033	0.002	0.144
p4oprobit	337	0.200	0.044	0.014	0.251
p5oprobit	337	0.589	0.166	0.109	0.983

Source: Own computation based on survey data, 2015

Appendix Table 10. Ethiopian coffee (green) production, area harvested and yield from 1961-2013

Variable	Obs	Mean	Std. Dev.	CV	Min	Max
Coffee production in tones (000s)	53	196157.3	52427.71	0.2672738	126188	376823
Area harvested in ha	53	411860.4	140094.2	0.3401497	218000	622000
Yield in Tones/ha	53	5406.075	2307.327	0.4268026	2245	9955

Source: Own computation, data obtained from FAOSTAT, 2016

Appendix Table 11: Multicollinearity test for determinants of technical inefficiency

Variable	VIF	1/VIF
Improved variety	1.96	0.5114
Chena woreda	1.82	0.5496
Decha Woreda	1.79	0.5587
Cooperative membership	1.78	0.5604
Average Age of coffee Tree	1.73	0.5768
Education	1.61	0.6200
Pruning	1.59	0.6292
Extension visit	1.59	0.6302
Mulching	1.46	0.6831
Training	1.42	0.7067
Intercropping	1.3	0.7708
Oxen	1.27	0.7878
Sex	1.24	0.8043
HH size	1.21	0.8286
Experience	1.19	0.8430
Coffee plot number	1.17	0.8551
Credit utilization	1.15	0.8671
Mobile ownership	1.12	0.8925
Distance to the coffee plots	1.04	0.9604
Mean VIF	1.44	

Source: Model result based on survey data, 2015

Appendix Table 12: Mean technical efficiency and cultivated coffee land size

Coffee land size	Mean TE
0.125 – 0.5	0.61
0.5 – 1.0	0.64
1.0 – 3.0	0.65
3.0 – 8.25	0.71
Total Mean Technical Efficiency	0.64

Source: Own computation based on survey data, 2015

Appendix Table 13. Summary statistics of households' perception to sources of risk

Variable	Obs	Mean	Std. Dev.	Min	Max
Production risk	337	4.24	0.74	1	5
Financial risk	337	3.01	1.22	1	5
Market risk	337	3.44	1.15	1	5
Institutional risk	337	2.48	1.37	1	5
Human related risk	337	1.83	1.19	1	5
Sex	337	0.85	0.36	0	1
Age	337	44.51	9.54	19	80
Education	337	0.49	0.50	0	1
Cooperative membership	337	0.67	0.47	0	1
Credit utilization	337	0.53	0.50	0	1
Family size	337	6.28	2.18	2	15
Extension visit	337	4.74	2.31	0	12
Livestock holding	337	3.99	2.18	0	15.1
Distance to coffee plots	337	1.24	4.28	0.05	74.05
Log coffee income	337	2.88	0.32	1.89	3.71
Efficiency score	337	0.65	0.19	0.156	0.944
Mobile ownership	337	0.69	0.46	0	1
Pruning	337	0.64	0.48	0	1
Improved variety	337	0.58	0.49	0	1
Training	337	0.71	0.45	0	6
Perceived precipitation	337	0.54	0.50	0	1
Frost incidence	337	0.57	0.50	0	1
Disease & pest infest.	337	0.69	0.46	0	1
Attack by wild animals	337	0.80	0.40	0	1
Price information at Primary markets	337	0.68	0.47	0	1
Government agent at primary markets	337	0.77	0.42	0	1
Follow ECX price	337	0.62	0.49	0	1
Price change before 5 years	337	0.42	0.49	0	1
Coffee price volatility compared to cereals	337	0.72	0.45	0	1
chena	337	0.35	0.48	0	1
decha	337	0.26	0.44	0	1

Source: Own computation based on survey data, 2015

Appendix Table 14. Summary statistics for governance structural choices

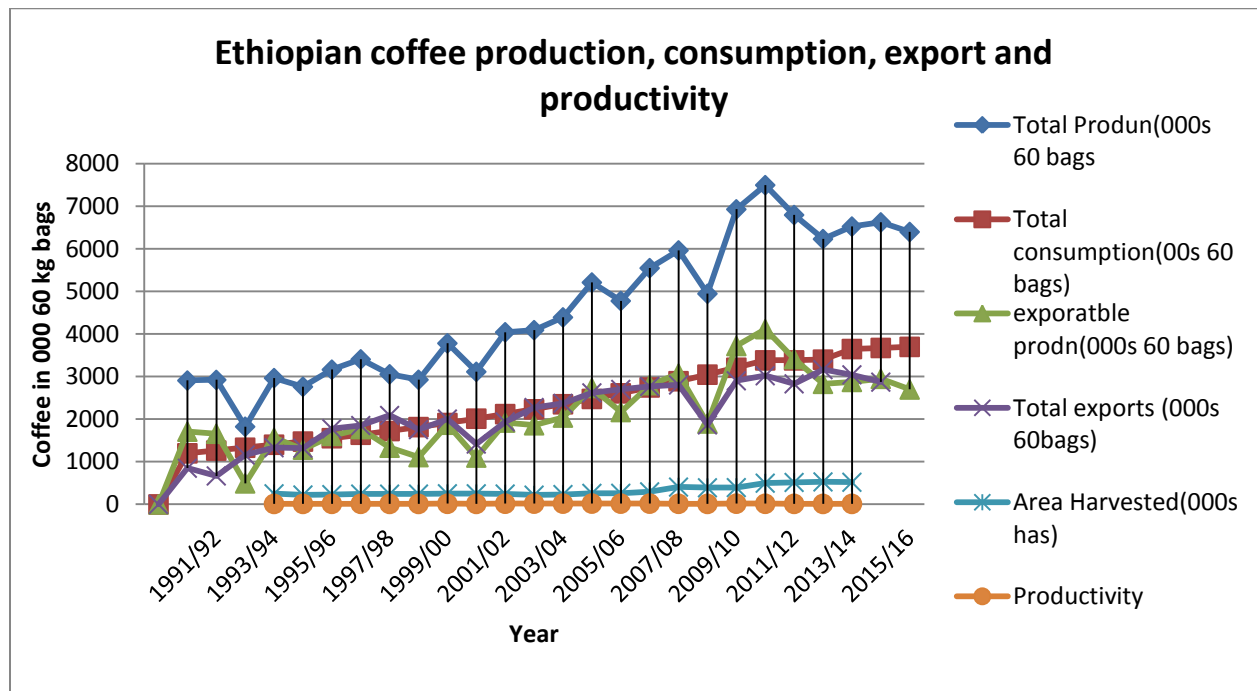
Variable	Obs	Mean	Std. Dev.	Min	Max
Family size	337	6.282	2.182	2	15
Education	337	0.493	0.501	0	1
Income from coffee	337	4.209	0.283	3.05	5.04
Human asset specificity	337	0.598	0.186	0	1
Connectedness	337	0.608	0.195	0	1
Uncertainty	337	0.553	0.177	0	1
Trust	337	0.543	0.499	0	1
Training	337	0.71	0.45	0	6
Communication of prices before sale	335	0.561	0.497	0	1
Coffee to total land ratio	337	0.540	0.229	0.07	1
perceived coffee quality	338	0.506	0.194	0	1
Efficiency score	337	0.646	0.191	0.16	0.94
Chena woreda	337	0.347	0.477	0	1
Decha woreda	337	0.264	0.442	0	1

Source: Own computation based on survey data, 2015

Appendix Table 15. Index estimation equations used for some variables

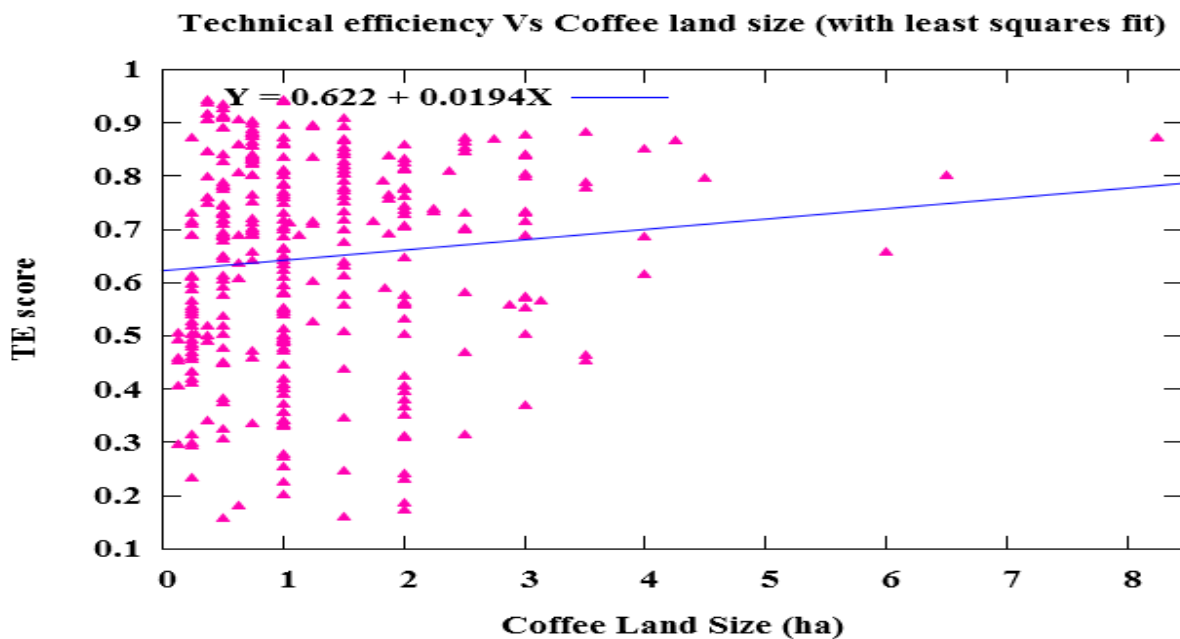
Variable	Equation used to make indexes
Human Asset Specificity	$\frac{(\text{Educational status} + \text{Cooperative membership} + \text{Experience})}{3}$
Connectedness	$\frac{(\text{Awareness about price paid} + \text{Awareness about quality required})}{2}$
Uncertainty	$\frac{(\text{Stability of coffee prices} + \text{Stability of quantity supplied} + \text{Stability of quality})}{3}$
Perceived coffee quality	$\frac{\text{Timely harvest} + \text{Uniformity of ripness} + \text{Training received on coffee quality}}{3}$

Source: Own computation based on survey data, 2015

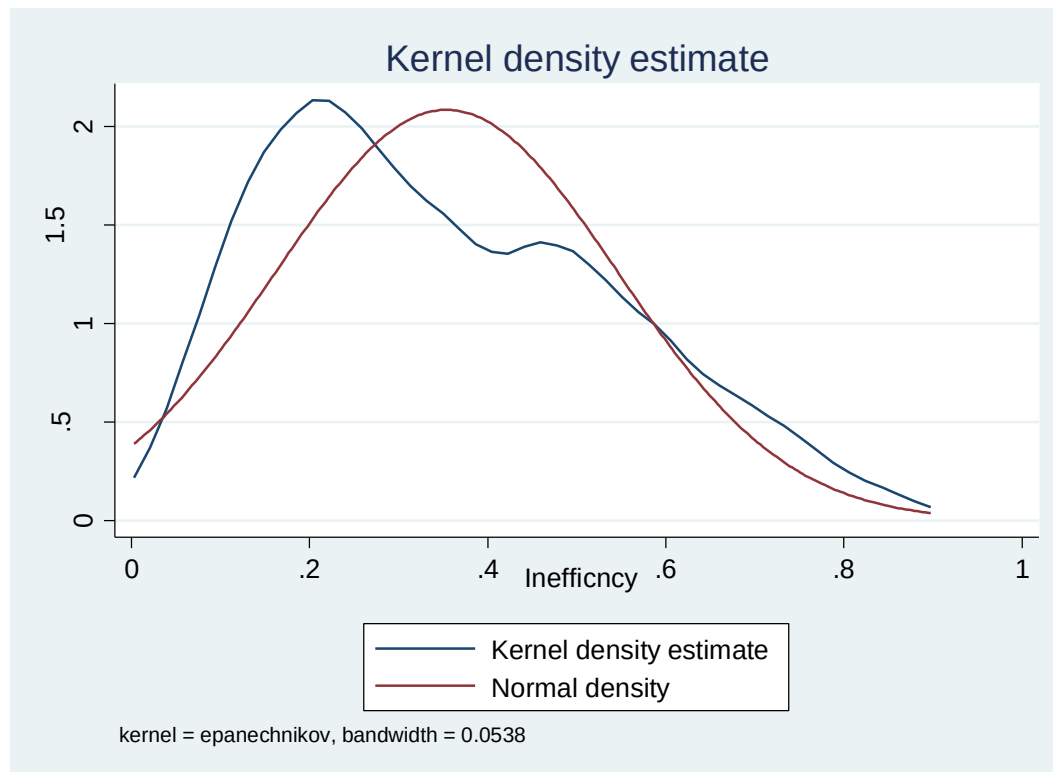


Appendix Figure 1: Ethiopia's total Arabica coffee production, total consumption, exportable production and actual exports in 1000 60 bags from 1990/91 to 2015/16.

Source: Own computation Data taken from ICO and FAOSTAT, 2015



Appendix Figure 2: Plot of TE score and coffee farm size



Appendix Figure 3: Kernel density estimate of TE under half-normal distribution

Appendix 7.3

Questionnaire used for smallholder coffee growers)

“This survey is conducted by Mebratu Alemu, a PhD student in Agricultural Economics (Haramaya University). The survey is to study Efficiencies, Risks and Governance Structure Choices along Coffee Supply chain in south western Ethiopia (Kefa Zone of SNNPR) in order to fulfill the requirement for a PhD Degree in Agricultural Economics. The information will not be reported as individual, and thus will be fully anonymous, without identity revealed.”

A. GENERAL INFORMATION

1. Name of the HH head (optional) _____ 2. Household ID <div style="border: 1px solid black; width: 100px; height: 20px; margin: 5px auto;"></div> 3. Name of respondent (if not head of household) _____	Cell phone? ____ Yes..1; No..2 If yes, which number? _____
---	--

B. IDENTIFICATION SURVEY TEAM MEMBERS

1. Enumerator's name:	_____
2. Supervisor's name:	_____
3. Date of the survey(EC):	a. Day : __,__ b. Month : __,__

C. HOUSEHOLD CHARACTERISTICS

1	2	3	4	5	6	7	8	9	10
woreda	Kebele	HH head sex: 1= male 2 = female	HH head's Age in years	Education: 0-No formal schooling 1-Primary school 2-Secondary school 3-Technical school 4-Other: Specify.....	HH size	Farming type: Crop=1 Livestock=2 Both = 3	Cooperative member: yes= 1 NO=2	Marital Status: Married=1 Single =2 Divorced=3 Widowed=4	Religion Orthodox..1 Muslim..2 Protestant..3 Catholic..4 Others..5

D. FARMING SYSTEM

1		Main Food Crops	Total Area planted (crops) in ha	Amount produced in Quintal in 2006	Amount Sold in Quintal in 2006	Price /quintal
1	Crops (other than coffee) and livestock	Maze				
		Tefe				
		Sorghum				
		Barley				
		Other Cash crops				
		spices				
		khat				
		Red pepper				
		Livestock owned:	No. heads (animals)	No. of heads sold	Value in Birr	
		Cows				
		Oxen				
		Goats				
		Sheep				
		Poultry				
		Horse				
		Donkey				
		Others				
2	Purpose of growing coffee	0- Environmental protection				
	Multiple answer is possible	1- Tradition/culture				
		2- Best money-making/commercial				
		3- Consumption				

		4-Export		
		5- Other (specify)		
3	What is the distance from your home?		Distance in kms	In minutes one way
		To get the seedlings		
		To get fertilizer		
		To nearest market you sell your coffee		
		To the farthest plot of coffee		
		To washing station		
		Depulping center		
		Gov't agricultural office		

E. Non-farm Employment

1	Had you or any member of the household worked non-farm in the year 2006?	yes	No	If yes, please fill the table for details			
				No of Person participated	Days worked	Payment/hour/day	Type of work

G. COFFEE PRODUCTION

In your estimate, what was the total value of sales of coffee in 2014: _____Birr?										
	1. How much of coffee in red cherries was harvested during this season? (in quintal)	2. b. "q1" is equivalent to: (in Quintal)	3. How much of coffee in dried whole cherries was harvested during this season? (in Quintal)	4. How much was the coffee production expressed in dried whole cherries in 2006 (add q2+q3)? (in Quintal)	5. How much of the harvested coffee was... USE AS A CONVERSION FACTOR 3 KG OF RED CHERRIES = 1 KG OF DRIED WHOLE CHERRIES)					
					a. ...sold as dried cherries? in quintals of whole dried cherries	b. ..Used for home consumption? Number of quintals of whole dried cherries	c. ...still in storage (at the time of interview)? Number of quintals of whole dried cherries	d. ...damaged and lost post-harvest (in any activity)? Number of quintals of whole dried cherries	e. ...used for gifts? in quintals of whole dried cherries	f. ... Used to lend to other people? in quintals of whole dried cherries
6	Is your coffee plots intercropped?			Yes	NO		If yes, with which crop it is intercropped?			
7	Did you apply any mulch in your coffee plots during the last 3 years before 6 months			Yes	No					
7	Do you use new Varieties of coffee trees?			1=yes 2=No If yes indicate the variety_____						
8	If your answer for Q.20 is yes, which one has more resistance to (E=existing, N= new variety)			1. Pest attack:_____ 2. Disease:_____ 3. Drought:_____ 4. Weed:_____ 5. If any other specify:_____						
9	Do have an experience in pruning coffee			Yes	No	If yes when do you prune coffee				

10	Did you harvest coffee timely?	1...Yes		2...No		
11	Is the ripeness of berry coffee in a lot uniform during harvest?	1...yes		2...No		
12	What type of processing technique do use for your coffee	1...Wet processing		2..dry processing		Both type None
13	What type of harvesting technique do you use for collecting coffee berry?	1..Strip harvesting		2. Selective picking	Both	If other (specify)
14	Have you received any training about coffee production and/or quality and/or marketing since the last 3 years?	1..Yes	2..No	If yes, how many times you received training since the last 3 years_____		
15	Do extension works visit you this year?	1..Yes	2..No	If yes, how many times they visited you in the year 2006 _____		
16	Average age of coffee tree in years					
17	Number of years growing coffee					
18	Do you apply irrigation to your coffee field	1=Yes		0=No		
19	What is the quality of the soil coffee is planted?	1. BetamLem.				
2. Lem.....						
3. Lem-Teuf...						
4. Teuf.....						
19	If you ever sell dry coffee	Method of depulping Coffee after harvesting?		0- Depulp using a stone		
1- Depulp using my own depulping machine						
2- Deepulp using paying machines of other people or						
3- Depulp at a depulping centre of cooperative						
Payment for depulping		4- Other				
		1- Amount paid in Birr per kg of cherries_____				
		2 Payment in kind: Number of sacks:_____				
		Birr per sack of cherries(1 sack=60kgs):_____				
		Days for depulping:	Days of drying:			
20	Amount of labour Supplied for coffee?	Number per season: Days of work		Ordinary/regular	Harvest/pick period	
		1- Family labour				

		2- Hired part-time				
		Total				
21	For the hired Labour	Wage type	1.Daily	2. weekly	3. monthly	4 . other
		Wage amount				
			Ordinary		Harvest	
		Days of work				
		Cost				
22	If the fertilizer is bought, amount and quantity used(this year)	Type	specification			Total Cost
		1- Manure	Baskets per hectare:	Num of baskets:	Price per basket:	
		2- Chemical	Kgs per hectare:	Num of kgs:	Price per kg:	
		3- pesticides	Kgs per hectare:	Num of kgs:	Price per kg:	
		1 bag=kg.....				
23	Are the inputs available in sufficient Quantities?		Seeds	Organic fertilizer	Chemical	pesticides
		0- Yes				
		1- Not always				
		2- Never				
		4- do not know				

H. AGRICULTURAL FINANCE AND CREDIT

1	Have you received credit last year?	1...Yes	2...No	If yes, please fill the table for details;			
	Credit Sources	Amount borrowed	Purposes and amount spent in birr				
			Coffee investment	Other investment	consumption	Festivities	Other (specify)
	Micro finance						
	Banks						
	Friends/Neighbors						
	Coffee collectors/traders						
	Idir/Iqub						
	NGO's						
	Others Specify						
	2	Saving Form	.Is this form of savings available in the kebele? Yes..1 No...2; I do not know...3				
	1.Local savings group (ekub or idir)						
	2.Savings and credit association						
	3.Banks						
	4.Micro-Finance Institution						

I. RISK PERCEPTIONS AND RISK RESPONSES

1	In your opinion, how is the current price of coffee as compared to:	Period:	1..higher	2..The same	3. lower	4. Do not know
		Before 5 years (2002 E.C) from now				
		After 5 years from now (2012 E.C)				
2	In your opinion , compared to prices of other crops, coffee price is	1.More risky	2.Moderately risky	3.Equally risky	4.Less risky	5.No risk at all
3	In your opinion please would you rank the following 5 major sources of risk in terms of importance to your coffee farm business? Note that 5 is the most important source of risk..and 1 is the least importance	Sources of risks	Rank	4 Have you managed the sources of risks (indicated on Q3.) at your own farm: 1. No, 2. Yes partly, 3. yes		
		Production risks ¹⁰				
		Marketing risks ¹¹				
		Financial risks				
		Institutional/legal risks				
		Human/personal risks				

10Production risk incorporates risks such as low rainfall, drought, hail or heavy rains, pests and disease, breakdown or unavailability of equipment and spare parts.

11 Marketing risks comprises (prices and costs) factors affecting risk include supply, demand and cost of production

Responses to risk management strategies							
4	In your opinion, do you think the following risk management strategies at your coffee farm are preferred and relevant? 1. yes 2. Not	Risk management strategies		1=yes 2=Not	Rate 1=the least important to 5 =the most important		
		Use Crop and livestock diversification					
		Make marketing contracts					
		Participate in non-farm employment					
		Participate in contract farming					
		Use Pest and disease management					
		Use ICT to manage coffee farm risks					
5	a.. In your opinion, please would you rank the following sources of risk to your coffee business/farm: 5 is the most risky factor to...1 is the lowest/no risk factor	Factors	Rankings	b. Have you been personally affected by any of these factors/events?	c..Is the risk factor avoidable?	If your answer for Q.C. is Yes ..What could be done to prevent it?	If your answer for q.c. is No what sort of preparation is necessary?
				Yes/NO	Yes/No		
		Factors under production risk					
		Coffee Berry disease (CBD)					
		Coffee wilt disease					
		Coffee rust					
		Drought					
		Pests					
		Weeds					
		Loss or theft					
		Hail					
		Frost					
		Soil erosion					
		High rain fall					
		Hail					
		Climate change					
		Factors under marketing risk					
		Coffee price fluctuation					
		Input prices increase					
		Factors under institutional risk					
		Land dispute					
		Frequent market and trade policy changes					
		High Gov't coffee regulation					
		Factors under financial risk					
		High Interest rate					

		Weak credit access					
		Human/personal risk factors					
		Human disease; illness and or death of a family member					

I1. Time preferences

1. Would you prefer to receive 800 Birr today or 700 Birr one month from today? _____1. 800 Birr Today; 2. 700 Birr next month;

2. Would you prefer to receive 800 Birr today or 800 Birr one month from today? _____1. 800 Birr Today; 2. 800 Birr next month;

I2. Risk aversion

We will show you six pictures of two urns. This is a hypothetical game we would like you to play. For each picture, you are allowed to draw one ball from one urn and the amount in Birr written on that ball would be given to you in this hypothetical game. In such a game, could you indicate which urn you would prefer to draw a ball from?

7. Drawing A (U1: 200; 200; 200; 200 – U2: 200, 200, 500, 0). I prefer: _____1. Urn 1,
2. Urn 2
8. Drawing B (U1: 300; 300; 300; 300 – U2: 300, 300, 1200, 0). I prefer: _____1. Urn 1,
2. Urn 2
9. Drawing C (U1: 200; 200; 200; 200 – U2: 50, 50, 50, 5000). I prefer: _____1. Urn 1,
2. Urn 2
10. Drawing D (U1: 400; 400; 400; 400 – U2: 400, 750, 1000, 150). I prefer: _____1. Urn 1,
2. Urn 2
11. Drawing E (U1: 100; 200; 300; 400 – U2: 100, 200, 400, 500). I prefer: _____1. Urn 1,
2. Urn 2

J. SHOCKS ON COFFEE PLOTS (IN PREPARATION OF HARVEST OF 2006)

1. P A R C E L N O	2. Coffe e plot numb er	3. The rains for this season were [...] compared to normal?	4. This season, were the rains earlier or later than normal this season?	5. This season, were the beans on this plot affected by pests or disease more or less than normal ?	6. This season, were the beans on this plot affected by pests or disease more or less than normal?	7. This season, most important insects/ani mals-pests that plot suffered from?	8. Type of disease that plot suffered from this season?	9. This season, was there more or less damage because of animals (monkeys/a pes) than normal?	10. This season, was the harvest picked too early (as green beans) to avoid beans being:	
		Less than....1 More than....2 Normal..... ...3	Early... ...1 Late..... 2 Normal.. 3	Less than... 1 More than...2 Normal 3	Less than.... 1 More than.... 2 Normal ...3	Leaf1 Stem2 Cherry....3 None..... 4	Coffee Berry Disease (coffee cholera).....1 Coffee Wilt disease....2 Other.....3 None.....4	Less than....1 More than....2 Normal...3	A Eaten by anima ls?	b. Stolen by huma ns?
									Yes... 1 No..2	Yes... 1 No.2

L. SALES OF DRIED CHERRIES, CONTRACT AND MARKETING OF HARVEST 2006 (CONTINUED)

1. T R A N S A C T I O N O N O	15. What was the most important means of transportation? Multiple responses are possible	16. What was the total cost spent on transport?	17. Did you receive (input) advances from the buyer?	18. Was there a second payment for this coffee (not dividend)?	19. How much was the second payment?	20. What was money of sales mainly used for? Multiple responses are possible
	By foot.....1 Own donkey.....2 Other donkey....3 Own cart.....4 Rented cart.....5 Motorized vehicle.....6 Other.....7 Combination.....8 None.....9	BIRR	Yes....1 No.....2	Yes....1 No.....2>>q.27	Birr/kg	1.Repayment debts 2.Agricultural inputs 3.Purchase food 4.Purchase drinks 5. Education-health expenditures 6. Purchase consumption goods 7.Other 8. Do not know
1						
2						

M. Type of contract

21	What type of contract you enter with coffee buyer	Formal contract	Informal contract	Both	No contract at all
22	What is the estimated amount of cost (in birr) you incurred for searching the buyer per transaction				
23	If formal, how much cost you incur for enforcing contract agreement with your buyer				
24	Do you or your coffee buyer invest money or your/his/her time to create strong relations during transactions?			1=yes; 0= otherwise	

N. Marketing of red cherries and dried cherries

Questions	Red cherries	Dried cherries
1. Do you have the option to sell cherries to a primary coffee market center (“yebuna meshecka gebeya”)? Yes.....1; No....2		
2. How many private traders/agents buy cherries in this primary market center?		
3. How many cooperatives buy cherries in this primary market center?		
4. Are prices posted in this primary market center? Yes.....1; No.....2		
5. Are you aware about the quality requirements of your coffee buyers (Yes...1, 0= not)		
6. If your answer for Q5. Is yes, is the price paid by buyers matches the quality of your coffee supply? (1= yes; 0= not)		
7. Is your harvesting period matches to demands of your coffee buyers? (Yes...1, 0= not)		
8. Is there a difference in price between the different buyers? Large.....1; Small.....2; None.....3		
9. In your opinion, is there a difference in price for different qualities? Large.....1; Small.....2; None.....3		
10. Is there a representative of the BoA/government at the primary market center? Always...1; Sometimes...2; Rare...3; Never...4		

O. Coffee Storage Structure

	1.Storage structure	2. What type of storage structure do you use? 1. Yes; 2. No
	a. In bags on the floor	
	b.In bags on small bed above floor or kot	
	c.Bamboo structure above floor (gotera); not in bags	
	d. Other	
	How do you mainly dry coffee?	Yes/ No
	Traditional beds	
	Raised beds made of mesh wire	
	On cemented floor	
	On bare ground	
	On the tree	
	On a mat or plastic sheet on the ground	
	Other	
	I do not dry	
	What were the storage losses that you incurred of the harvest of 2006? _____ quintals of whole dried cherries	
	In your opinion, the quality of coffee during storage mostly:	Yes/No
	Improved	
	Stayed the same	
	Worsened	

P. Labor arrangements in harvesting (for the harvest 2006)

1. Did you hire (pay) people for coffee harvesting? ____ Yes....1; No....2
2. How long lasted the period that you employed people for harvesting? ____ days
3. Does the payment vary with the quality of harvest? ____ Yes.....1; No.....2
4. If good quality coffee is harvested, do you give a bonus? ____ Yes.....1; No.....2
5. How often do you pay the workers? _____ Daily....1; Weekly....2; 3. Monthly....3; All at once....4
6. Do you provide food on top of payment? ____ Yes.....1; No.....2
7. What was the payment arrangement? _____ 1. Fixed sum per kg harvested 2. Share-harvesting; 3. Lump-sum per day [MULTIPLE ANSWERS POSSIBLE]

Q. If fixed sum per kg harvested:

8. How much was the average payment? _____ Birr/kg
9. Did the payment change over the course of the harvest period? _____ Yes.....1; No.....2

If share-harvesting (paid in kind):

10. What was the share of the harvest that went to the owner, on average: _____kgs for every _____kgs harvested
11. Did the payment change over the course of the harvest period? _____ Yes.....1; No.....2

If lump sum per day:

12. What was the average price for a day: _____ Birr/day for adult males; _____ Birr/day for adult females; _____ Birr/day for children
13. Did the payment change over the course of the harvest period? _____ Yes.....1; No.....2

R. Preferences of red versus dried cherries

11. In this kebele, do you have the option to sell red cherries? _____ Yes.....1; No.....2; If yes, since which year: Ethiopian Calendar Year: |_|_|_|_|
12. Did you sell more red cherries than you wanted because you were obliged to do so by the DA/authorities? _____ Yes....1; No....2
13. Do you think that it is more profitable to sell coffee as dried cherries than as red cherries? _____ 1. Dried cherries more profitable; 2. Red cherries more profitable; 3. The same; 4. It depends from year to year
14. In your opinion, if the price of red cherries was 10 Birr per kg, the price of dried cherries should be _____ Birr per kg of whole dried cherries at the same moment to be equally profitable.

S. Market regulation

15. Does the BoA/government in this kebele decide the (starting and ending) dates when you are allowed to sell cherries? _____ Yes.....1; No.....2
16. If yes, are these dates respected? _____ By all farmers....1; By most farmers...2; By few farmers....3; By none.....4
17. If yes, are these dates appropriate in your opinion? _____ Yes....1; No....2
18. Does the BoA/government in this kebele set prices for cherries? _____ Yes....1; No....2
19. If yes, are these prices respected? _____ By all traders....1; By most traders...2; By few traders....3; By none.....4

20. Did you pay DAs or other officials for their activities in the coffee sector? _____ Yes....1;
No....2

21. If yes, how much did you pay them in the last 12 months? _____ Birr

T. Quality

22. Do your buyers check the quality of the berries that you sell? _____ Yes....1 ; No....2

23. Do you get a lower price when cherry quality is poor? _____ Yes....1 ; No....2

24. When cherry quality is poor, does the buyer make you sort your berries and only accept the good ones? _____ Yes....1 ; No....2

25. How do the buyers mainly check quality? _____ Visual....1 ; By smelling...2; By tasting...3 ; Other....4

U. Coffee certification

26. To your knowledge, is your coffee certified? _____ Yes...1; No....2; Do not know....3

27. If yes, what type of certificate:

- a. Fair-trade: _____ Yes...1; No....2;
- b. Forest Alliance : _____ Yes...1; No....2;
- c. UTZ : _____ Yes...1; No....2;
- d. Organic : _____ Yes...1; No....2;
- e. Fair-trade/Organic : _____ Yes...1; No....2;
- f. Bird-friendly : _____ Yes...1; No....2;
- g. Other: _____ Yes...1; No....2

V. Market information

28. How do you mainly access price information on coffee? _____ *Other farmers...1; Traders...2; Through radio...3; Through mobile phone...4; Through TV...5; No timely information...6; Others...7*

29. Is there an ECX electronic board showing prices on the place where you sell? _____ Yes...1 ;
No....2

30. Do you follow the prices of ECX? _____ Yes....1; No....2

31. How do you follow ECX prices?

- a. Radio: _____ Yes....1; No....2
- b. TV: _____ Yes....1; No....2

c. Mobile Phone (sms): _____ Yes....1; No....2

d. Electronic board: _____ Yes....1; No....2

e. Internet: _____ Yes....1; No....2

32. Does knowing the ECX price help you negotiate better prices with the buyer in your opinion? _____ Yes....1; No....2

33. Does knowing the ECX price help you in the choice in the buyer in your opinion? _____ Yes....1; No....2

34. If prices for different grades of coffee on ECX are mentioned, do you understand what these different grades mean for your coffee in this region? _____ Yes....1; No....2

W. Mobile phones

35. Do you or anybody in the household own a mobile phone? _____ Yes....1; No....2

36. Since when do you own a mobile phone? Ethiopian Calendar Year: |_|_|_|_|_|

37. Do you use the mobile phone to check on prices? _____ Yes....1; No....2

38. Do you use the mobile phone to call coffee traders? _____ Yes....1; No....2

39. Do coffee traders use the mobile phone to call you? _____ Yes....1; No....2

40. In your opinion, does the ownership of a mobile phone benefit your coffee production/marketing? _____ Yes....1; No....2; Do not know...3

41. In the last 12 months, did you try using the phone for your coffee production/marketing but the network did not work? _____ Yes....1; No....2

42. If yes, what was the longest period that the phone did not work because of lack of network? Number: _____ Time unit: _____ 1. Hours; 2. Days; 3. Weeks

Appendix 7.4.

Focus group discussion and key informant interview questions

1. COFFEE PRODUCTION, RISK PERCEPTION AND GOVERNANCE ISSUES

- 1.1. How do you evaluate the overall production and productivity of coffee in Kefa zone in general
- 1.2. Do you believe smallholder coffee growers in your area are productive? If not what do you think are the major challenges or bottlenecks not to be productive?
- 1.3. How do you rank or rate sources of coffee risks in your area (production, marketing financial, institutional and human related risks)
- 1.4. Are there any interventions taken by any stakeholder in your area to reduce or adapt the above sources of risks of coffee?
- 1.5. How do you evaluate the overall asset holding of smallholder coffee growers?
- 1.6. Do you think there are losses of coffee while harvesting and processing?

2. COFFEE MARKETING AND ASSOCIATED PROBLEMS

- 2.1. How do you evaluate the overall coffee marketing and transaction in your area
- 2.2. What type of coffee is highly marketed in your area?
- 2.3. Is there market access problem in the remote areas to supply their coffee to nearby primary markets?
- 2.4. To whom do you think the smallholder coffee growers transact their coffee mainly and please would you tell the overall chain of coffee transactions in the area?
- 2.5. During coffee transactions how and where do you think smallholder coffee growers obtain price information?
- 2.6. Which actor do you think is benefiting more from coffee transactions?
- 2.7. Please would you indicate coffee transaction problems or marketing risks in your area?
- 2.8. What do you suggest to solve problems existing in coffee production and marketing in your area?
- 2.9. How do you evaluate the perception level of smallholder coffee growers to different sources of risk and risk management strategies?