# Determinants of Wheat Commercialization and Its Effect on Income of Smallholder Farmers: *A Case Study of Basona Werana District, North Shewa Zone, Ethiopia*

*A Thesis submitted to the School of Graduate Studies of Jimma University in Partial Fulfillment of the Requirements for the Award of the Degree of Masters of Science in Industrial Economics*


*BY:*

***KALKIDAN NEGASH***




**JIMMA UNIVERSITY**

**COLLEGE OF BUSINESS AND ECONOMICS**

**MSc PROGRAM**



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**JIMMA, ETHIOPIA**

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## Under the Guidance of

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# CERTIFICATE

This is to certify that the thesis entitles "*Determinants of Wheat Commercialization and Its Income Effects on Smallholder Farmers: A Case Study of Basona Werana District, North Shewa Zone, Ethiopia",* submitted to Jimma University for the award of the Degree of Master of Industrial Economics (MSc) and is a record of valuable research work carried out by *Mrs. Kalkidan Negash* under our guidance and supervision.

*Therefore, we hereby declare that no part of this thesis has been submitted to any other university or institutions for the award of any degree or diploma.*

| *Main Advisor's Name* | *Date* | *Signature* |
|---|---|---|
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| *Co-Advisor's Name* | *Date* | *Signature* |
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*As a member of the Board of Examiners of the M.Sc. Thesis-Open Defense Examination, We certify that we have read, evaluated the Thesis prepared by Kalkidan Negash, and examined the candidate. We recommended that the Thesis be accepted as fulfilling the Thesis requirement for the Degree of Masters of Science in Industrial Economics.*

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| *Internal Examiner* | *Signature* | *Date* |
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| *External Examiner* | *Signature* | *Date* |

# DECLARATION

I hereby declare that this thesis entitled "*Determinants of Wheat Commercialization and Its effect on Income of Smallholder Farmers: A Case Study of Basona Werana District, North Shewa Zone, Ethiopia*" has been carried out by me under the guidance and supervision of Sisay Tolla (Assistant Professor) and Mohammedsani Ali (MSc).

The thesis is original and has not been submitted for the award of the degree of diploma any university or institutions.

| Researchers name | Date | Signature |
| --- | --- | --- |
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# ABBREVIATIONS AND ACRONYMS

ADLI-------- Agricultural Development Lead Industrialization

ANOVA---- Analysis of Variance

ARDO----- Agricultural and Rural Development office

ATT------- Average Treatment Effect

BLUE------ Best Linear Unbiased Estimator

CIA--------- Conditional Independence Assumption

CSA-------- Central statistical authority

CS---------- Common Support

DA--------- Development Agent

ETB-------- Ethiopian Birr

FAO-------- Food and Agricultural Organization

FDRE------ The Federal Democratic and Republic of Ethiopia

GDP------- Gross Domestic Product

GTP------- Growth and Transformation Plan

HCI-------- Household Commercialization Index

OLS-------- Ordinary Least Square method

NBE-------- National Bank of Ethiopia

NPC-------- National Planning Commission

NSHZ-------- North Shewa Zone Administrative office

PASDEP----Plan for Accelerated and Sustainable Development to End Poverty

PRSP-------- Poverty Reduction Strategy Paper

PSM--------- Propensity Score Matching

SNNP-------- South Nations Nationalities and Peoples of Ethiopia

STATA-------- Statistical data

VIF---------- Variance Inflation Factor

WB---------- World Bank

## *ABSTRACT*

*In Ethiopia, where cereal production and marketing are the means of support for millions of smallholder households in terms of consumption, employment and marketing. Wheat is the core cereal crop in Ethiopia in general and at Basona Werana district in particular which support smallholder households with consumption and marketing. The objective of this study was to identify determinants of smallholder wheat farmer decision to participate in output market and level of marketed output and its income effects on smallholder farmers. Multi-stage sampling process was applied. The study used data on 360 respondents that are collected through structured questioner from Basona Werana districts in North Shewa zone. The descriptive statistics, Double-hurdle model and Propensity score matching inferential methods were employed to analyze the data. Average wheat commercialization index indicated that out of sampled households about 37.78%, 54.44% and 7.78% of households were subsistence, semi-commercial and fully-commercial, respectively. The first hurdle model indicated that, land size allocated to wheat, credit access, access to market price information, family labor, total amount of wheat produced and membership of informal institutions positively influence wheat commercialization participation decision while size of family member, participation of off-farm income, distance from the market and preparation of feasting has negative effect on it. The second hurdle result found that access to market price information, total amount of wheat produced, cash expenditure for input utilization and membership of informal institutions positively affects intensity of wheat commercialization while preparation of feasting have negatively affects. Furthermore, propensity score matching model result indicates that wheat commercialization has a significant and positive effect on income of smallholder households. Therefore, the concerning body should design appropriate policy and strategies that improve the participation of the households in wheat commercialization through investing in transaction cost reduction activities, increasing credit access and empowering informal institutions.*



**Keywords:** Commercialization, income, Double hurdle model, propensity score matching, Basona Werana

# CHAPTER ONE

# 1. INTRODUCTION

This chapter presents the introductory parts of the paper. It comprises background notion of the research and the problem that needs this research desired. Objectives of the study, significance of the study, scope and organization of the paper are also the parts of this section.

## 1.1 Background of the Study

Agriculture is the pillar of the Ethiopian economy, and more than 34.9% of the national growth domestic product of the country is expanded from the agricultural sector. Agricultural economy was registered 7.7% growth in 2017/2018, slower than the 10.9% expansion recorded in 2015/2016. This growth was attributed to 12.2% rise in industrial output, 8.8% expansion in service sector and 3.5% growth in agriculture (NBE, 2018).

In Ethiopia, out of total agricultural productions cereal production and marketing are the means of support for millions of smallholder households, which books for 80% of total cultivated land(CSA, 2019), 60% of rural employment, more than 40% of a typical household's food expenses, and more than 60% of total caloric intake (FDRE, 2017). Therefore, cereal production and marketing are the incomes of livelihood scheme for millions of smallholder households in Ethiopia which allows them to acquire high produce for consumption and sale (Taffesse et al., 2013).

Wheat (*Triticumaestivum L.*) is an essential industrial and food grain, which ranks second among the most important cereal crops in the world after rice, and traded internationally (FAO, 2017). However, the area coverage, production and productivity of wheat is increasing from time to time steadily, it was fluctuating as a result of population growth, changing food preferences and a strong urbanization trend(Abate, 2019a).

When we come to the production of wheat, Ethiopia is the second largest producer of wheat in sub-Saharan Africa although, yields remain considerably below the global average due to several production constraints (Netsanet et al., 2017). In Ethiopia, on average, wheat production, area coverage and its productivity have revealed growing rate specially from 2005 to 2017 (Anteneh & Asrat, 2020).

(Manjur, 2018), indicates that there is a tough concern amongst the farming community towards converting the subsistence mode of production to more market oriented and commercialized agricultural production which in turn is an attitudinal change in the community. Therefore, agricultural commercialization happens when agricultural sectors depend on progressively on the market for the sale of produce and for the attaining of production inputs, including labor (Poulton, 2017). Commercialization also defined as, enhancing technologies, achieving greater productivity per land and labor and expand market participation (Rajni, 2016).

In Ethiopia 95% of the total area is cultivated by smallholder farmers and contribute 90% of the total agricultural output(Dube et al., 2019). Ethiopian government plans during GTP II (2014/15-2019/20), agriculture and predominantly smallholder agriculture as a solitary most significant basis of economic growth. Improving the income of small holder farming households through advanced shift from producing subsistence crops into high value crops, placing an efficient agricultural marketing structure are the further strategic guidelines to be followed during this development plan period (NPC, 2016).

According to Getahun, (2020), smallholder farmers are defined as the basis of land and livestock holdings, cultivate less than two hectares of land and own only few livestock. In Africa also, smallholder agriculture, has recognized to be as at least as proficient as larger farms when farmers have got comparable provision services and inputs such as seed, fertilizer, and credit (Poulton, 2017).

A result of a study of Muricho(2017), indicates that agricultural commercialization largely growths annually per capita household income among commercialized and non-commercialized. Hence, market participation significantly increases household income (Camara, 2017), Commercializing smallholder agriculture is an important path towards economic growth and development countries that depend on agricultural sector (Manjur, 2018).

Basona Werana district was found in North Shewa zone, Amhara region of Ethiopia. Smallholder agriculture was the main living basis for the majority of peoples in North Shewa zone. The principal cereal crop products in north Shewa zone especially in Basona Werana district include wheat, bean, pea and barley (Agriculture and Rural development office of North Shewa zone, 2021). Therefore, this study was conducted with the aim of examining the determinants of wheat commercialization and its effect on incomes of smallholder farmers.

## 1.2 Statement of the Problem

A public investment in infrastructure and agricultural productivity supplementation is a typical frequent activity of Ethiopian economic growth. Though, the performance of agriculture was not satisfactory as poverty remained. Lack of appropriate policies and strategies was considered as the ultimate reason for the sectors past stagnation. Therefore, the Ethiopian governments pursue the agricultural development lead industrialization (ADLI) which focuses on improving food security, commercialization of agriculture, the extension of credit to smallholder farmers and industrialization (Dube et al., 2019).

Market participation among smallholder farmers in developing countries is a vital economic endeavor subsequently it uplifts their poverty prestige and certifies food security (Mpombo, 2018). So, many developing countries with a majority of smallholder farmers are continue to initiate agricultural transformation from subsistence to commercialization (Muricho, 2017). However, Smallholder farmers face several constraints that restrict their access to markets and preclude them from taking advantage of market opportunities (Kyaw et al., 2018). The study of Manjur, (2018), also shows that commercialization of smallholder farming is not yet high enough to enable farmers benefit from increased income and the farmers are not yet out of the subsistence oriented agriculture.

According to Afework & Endrias, (2016) commercialization in general affected by population growth and demographic change, technologies, institutions, risks, markets and their integration, transaction costs, asset holdings of the households, and policy aspects. Social, cultural infrastructural and economic factors also influence smallholder commercialization's (Getahun, 2020). Lack of supportive institutions, poor access to productive resources, markets, education level of households, lack of skills, limited commercial mindset and negative beliefs are also the constraints to smallholder commercialization (Takesure, 2017).

The study of Cheber, (2018), also indicates, as smallholders move from subsistence towards market orientation, the success and failure of the process is influenced by several environmental (like socioeconomic factors), farm level (like farm resources) and individual (like skills) determinants. When these factors are favorable, they facilitate/enable the process making it successful, but when unfavorable hinder the process causing its failure.

Wheat is selected for the reason that it was predominantly grown and marketed by majority of the smallholder farmers in the study area both for food and market purpose. Although, wheat commercialization has got great prominence, smallholder farmers face challenges to participate in the wheat market(Endalew et al., 2020).

Participation in crop commercialization has a positive and significant impact on smallholder livelihoods through improved income. (Hailua et al., 2015). On the other hand, empirical evidences indicate that commercialization of smallholder farmers has the potential to enhance incomes and welfare outcomes and take them out of poverty if constraining factors such as lack of capital, farming and commercialization skills, high transaction costs, lack of infrastructure, lack of information and lack of education could be eliminated (Ahmed, 2017).

Wheat is one of the main food and cash crops of the study area. But, supply of wheat in the study area cannot still satisfy the demand of the nearby markets. It was hindered by the shortage of improved seed, absence of nearest market, high labor wage per day and lack of skill to use modern technology.

Succeeding this, to know the strong potentials and favorable effects of wheat commercialization on productivity and income, factors affecting commercialization of wheat produced are essential. So that the current study estimated factors that determine wheat commercialization participation decision and its intensity separately. Moreover, the effects of informal institutions and feastings on wheat commercialization of smallholder farmers in the study area were examined. Hence, wheat is major cash crops in the study area the effects of wheat commercialization on households' income were also examined by using impact analysis model.

## 1.3 Research Questions

This research was going to answer the following questions:

- What is the current level of commercialization of wheat at the Basona Werana districts?
- What are the factors that determine the decision to commercialization of wheat of smallholder farmers at the study area?
- What are the factors that determine the intensity of wheat commercialization of smallholder farmers at the study area?
- Does the commercialization of wheat have an impact on welfare of smallholder farmers?

## 1.4 Objectives of the Study

### 1.4.1 General objective

To examine the determinants of wheat commercialization and its effects on income of smallholder farmers in Basona Werana districts of North Shewa zone.

### 1.4.2 Specific objectives

- To indicate the current level of commercialization of wheat at the Basona Werana district;
- To analyze factors that determine wheat commercialization decision of smallholder farmers at the study area;
- To identify factors that determine the intensity of wheat commercialization of smallholder farmers at the study area;
- To distinguish the effects of wheat commercialization on the earnings of smallholder farmers at the study area.

## 1.5 Hypothesis of the Study

The study formulated the following hypothesis;

The determinants of wheat commercialization decision of smallholder households

$H_{01}$: Age does not influence the participation of smallholder household's in wheat commercialization.

$H_{02}$: Sex does not influence the participation of smallholder household's in wheat commercialization.

$H_{03}$: Educational level does not influence the participation of smallholder household's in wheat commercialization.

$H_{04}$: Family size does not influence the participation of smallholder household's in wheat commercialization.

$H_{05}$: Farm size allocated to wheat does not influence the participation of smallholder household's in wheat commercialization.

$H_{06}$: Frequency of extension contact does not influence the participation of smallholder household's in wheat commercialization.

$H_{07}$: Access to market information does not influence the participation of smallholder household's in wheat commercialization.

$H_{08}$: Distance from the market does not influence the participation of smallholder household's in wheat commercialization.

$H_{09}$: Off-farm income participation does not influence the participation of smallholder household's in wheat commercialization.

$H_{10}$: Access of credit using does not influence the participation of smallholder household's in wheat commercialization.

$H_{11}$: Family labor participated on wheat harvesting does not influence the participation of smallholder household's in wheat commercialization.

$H_{12}$: Total amount of wheat produced does not influence the participation of smallholder household's in wheat commercialization.

$H_{13}$: Cash expenditure for input utilization does not influence the participation of smallholder household's in wheat commercialization.

$H_{14}$: Preparation of feasting does not influence the participation of smallholder household's in wheat commercialization.

$H_{15}$: Membership in informal institutions does not influence the participation of smallholder household's in wheat commercialization.

Effect of participation in wheat commercialization on household's annual income

$H_{01}$: Participation in wheat commercialization does not help to increase annual income of smallholder households.

## 1.6 Significance of the Study

This study was conducted on the determinants of commercialization of wheat and its effects on incomes of smallholder farmers. This study gives better insight in to the role of commercialization in increasing productivity and improving income of smallholder farmers. Thus, the result of this study provides valuable input to formulate appropriate crop production and marketing policies and procedures. Most importantly, this study gives a better awareness into the role of commercialization of wheat in improving income and reducing poverty of smallholder farmers.

## 1.7 Scope of the Study

This study was bounded to identifying demographic and socioeconomic factors determining the decision of smallholder farmers to commercialize (not commercialize) wheat, determinants of wheat commercialization intensity and analyzing its income effects on smallholder farmers. All these aspects were dealt in the context of Basona Werana districts of North Shewa Zone for the 2020 production year.

## 1.8 Structure of the study

This research paper is organized into five chapters: Where the first chapters presents the introduction part which contains background of the study, statement of the problem, objectives (general and specific), research questions, significance of the study, scope of the study and organization of the study. The second chapter presents related literatures which is theoretical and empirical. Then it is followed by chapter three which presents the study methodology as well as the data and its sources, the specific variables used and their hypothetical expected outcomes. The empirical findings and respective interpretations was presented and discussed in chapter four. Finally, the fifth chapter incorporates conclusions and recommendations.

# CHAPTER TWO

# 2 LITERATURE REVIEW

In this chapter the reviews of related literatures were stated. The first part is review of theoretical literatures which consists evidences that help to construct clear understand about the research idea and applications of terms specified in the paper. Whereas, the second part entails empirical reviews of related literatures.

## 2.1 Theoretical Literature Review

### 2.1.1 The Role of Agriculture in Development

Agriculture has been playing important role in the development of nations for centuries. The World Development Report 2008 states that agriculture can produce faster growth, reduce poverty and sustain the environment, if it is made to work in concert with other sectors of the economy. The report indicates three ways of agriculture contributes to development: as an economic activity, as a livelihood and as a provider of environmental services (WB, 2018).

As a source of livelihood, agriculture affords housing to 86% of the rural poor. In fact, nearly half of the world population lives in rural areas and most of these depend on agriculture; smallholder households are about 1.5 billion. Interestingly, the decline in poverty rate of developing countries from 28% to 22% in 2012 is mainly attributed to falling poverty in rural areas; and 80% of the decline in rural areas is related exclusively to better conditions in rural areas(Poulton, 2017).

As an economic activity, agriculture supports the rural poor to succeed food security meanwhile, majority of them arise their incomes from agricultural production. Specifically, this contribution becomes intense in the case of Sub-Saharan Africa where majority of the people practice highly variable domestic production, limited tradability of food staples and foreign exchange constraints. Although the negative environmental outcomes-such as underground water depletion, soil exhaustion and agrochemical change, associated with agriculture, it is being acknowledged now that agriculture can positively affect the environment by repossessing carbon, managing watersheds and preserving biodiversity (Zemedu et al., 2018).

Agriculture is the main and important sector in Ethiopia also. About 85% of the population lives in rural areas where agriculture is the dominant economic activity and the largest sector in the economy contributing to about 34.9 percent to GDP and 90 percent to the export earnings(CSA, 2018).

Smallholder farmers in Ethiopia account for most of the Ethiopian population and the food grain production. Smallholder farms cultivate approximate to 95% of the total cropped land and produce more than 90% of the total agricultural output in Ethiopia(Getahun, 2020).

### 2.1.2 Operational Definitions of Smallholders

There is no universally accepted definition of a small-scale farm or small holding exists. 'Small' may refer to the area cultivated, the most common criterion used, but it may equally apply to invested and working capital, or to the number of workers. Even taking land as the criterion, defining the area considered 'small' is made difficult owing to the differing soil quality, rains, slope and access to irrigation that apply to any unit of land. Approved these credentials, FAO has adopted a 2ha threshold as a broad measure of a small farm(Wiggins et al., 2014).

Smallholder is the one with limited land accessibility, poor-resource endowments, subsistence-oriented and highly susceptible to risk. On the other hand, the smallholder may or may not display all these magnitudes of smallness at once (Abera, 2009).It is also common to set numeric value as a way to define small farms. (Minde, 2020)note that some literature define small farms as those with less than two hectares of crop land while others define smallholders as those endowed with limited resources, such as land, capital, skills and labor (Martey, 2014).Similarly, there are also those authors who often describe small farms in terms of the low technology they mostly use, their heavy dependence on household labor and their subsistence orientation(Wiggins et al., 2014).

In Ethiopia also meets a conservative meaning of a households with less than two hectares of lands is defined as smallholder farmers (FDRE, 2018). Even that the smallholders in Ethiopia are known for their resource constraints such as capital, inputs and technology; their heavy dependence on household labor; their subsistence orientation; and their exposure to risk such as reduced yields, crop failure and low prices (ibid).

### 2.1.3 Operational Definition of Agricultural Commercialization

Commercialization as a concept is multi-dimensional and no one definition has been able to capture all its facets. The definitions differ in focus and breadth, which has also influenced its measurement. Many literatures including Voun Braun et al. 1994, state agricultural commercialization can happen on the output side with increased marketed surplus, but it can be happen on the input side with the increased purchased inputs. Therefore, commercialization refers both to marketing of high value cash crops (such as pulse, oil and horticultural crops) and also primary food crops (such as teff, wheat and barley)(Wiggins et al., 2014).

Smallholder commercialization is a crucial feature of the structural transformation process considered by most development economists to be the major pathway from a semi-subsistence agrarian society to a more diversified and food secure economy with higher general living standards. Furthermore, Smallholder agriculture is one of the principal economic occupations in the world and is the leading source of income and employment for the 70 percent of the world's poor who live in rural areas (Poole, 2017).

Generally, agricultural commercialization targets to convey about a move from production exclusively for domestic consumption to production dominantly market-oriented. So, commercialization does not only occur by reorienting of agriculture to high valued cash crops but it could also occur by reorienting it to primary food crops(Zemedu et al., 2018).

### 2.1.4 Processes and Measures of Agricultural Commercialization

#### 2.1.4.1 Process of Commercialization

In almost all developing country cases, commercialization took place by slow and marginal change, with few dramatic changes to farming systems. Farmers planted small areas to crops for sale, typically 0.5ha or less, and usually less than half the land farmed, the rest being sown to food crops. But, since crops grown for sale, commercializing farmers have habitually strengthened their production, using external inputs such as improved seed and manufactured fertilizer. They also increased labor per hectare, since irrigation and horticultural crops require more operations(Wiggins et al., 2014).

The main drivers of commercialization seen were market demand and support from outside agencies such as; government agencies, processors, exporters and a national farmer enterprise providing technical assistance on production and marketing and occasionally access to inputs. Generally, commercialization can occur when subsistence oriented farmers shifted to producing market oriented products by using improved seeds and external inputs (ibid).

According to Afework & Endrias(2016), adopted from Pingali et al. 1995, there are three levels of market orientation termed as subsistence systems, semi-commercial systems and commercial systems based on the farm households' objective for producing a certain crop, their source of inputs, their product mix and their income source as far as food production systems are concerned. Subsistence is a stage at which the farmers consume all of its products.

The process by which smallholders' commercialization takes place and follows unique path ways. The usual path of commercialization of smallholder agriculture starts with growth in the marketable surplus of agricultural commodities in both agro-ecologies. To be more specific in highland areas this could be achieved by producing marketable surplice of staples and continues until it becomes the dominant portion of the total output of the household. This market orientation pathways of farm households is quite appropriate to Ethiopia, as a predominantly agrarian country and smallholder dominated nation (Afework & Endrias, 2016).

### 2.1.4.2 Measuring Agricultural Commercialization

Before maintaining the measurement of agricultural commercialization firstly, stating its indicators is better. Changes in producer incomes, changes in the distribution of income (between men and women), changes in total volume of product sales and proportion of product sales via new market outlets are some indicators of agricultural commercialization (Poole, 2017). Share of production sold, volume or value sold, share of land devoted to crops that are sold, quantity of inputs purchased and quantity or value of labor hired are the indicators of agricultural commercialization (Poulton, 2017). Hence the current study is about the commercialization of crop, a simple household commercialization index (HCI) gives the degree of commercialization as the percentage of crop production marketed;

Household commercialization index (HCI) = $\frac{value\ of\ all\ crop\ sales}{value\ of\ all\ crop\ production} * 100$

Hence this study was conducted to examine wheat commercialization of smallholder farmers, the wheat commercialization index can be calculated:

Household wheat commercialization index (HCI) = $\frac{Amount\ of\ wheat\ sold\ in\ the\ market}{Amount\ of\ total\ wheat\ produced} * 100$

Where, a value of zero signifies total subsistence, and an index approaching 100 indicates higher degrees of commercialization.

## 2.1.6 Spatial Distribution of Wheat Production in Ethiopia

The leading aspects inducing the distribution of wheat production in Ethiopia are rainfall and altitude. Wheat grows paramount at temperatures between 7$^{o}$C and 21$^{o}$C and with rainfall between 750 mm/year and 1600 mm/year. Since altitude strongly influences the temperature in Ethiopia, most wheat is grown at an altitude of 1500 meters above sea level and above(FAO, 2017).

For this reason, the main wheat growing areas of Ethiopia are the highlands of the central, south-eastern and northwest parts of the country. In terms of regional contribution, the production of wheat originates from Oromia (57.4%), Amhara (27%), SNNP (8.7%) and Tigray (6.2%); and more than 41% of the annual wheat production comes from only three zones in Oromia and one in Amhara regions (Seyoum Taffesse et al., 2013). In Amhara region wheat yields are 2.1 t/ha with its 27% contribution for total national wheat production.

## 2.1.7 Wheat Marketing

Wheat marketing refers to the practice of moving wheat from farmers to consumers (Gebremedhin & Tegegne, 2012).Wheat is produced mainly for consumption in Ethiopia and its trend is increasing. Besides its consumption, it also used for markets; it contributes to 80% of the total marketed quantity of cereal production; but, there is a large demand-supply gap. Smallholder farmers market their wheat produce only 20% of production and 80% of their total production are used for consumption; the per capital share of quantity consumed in pastoral areas, humid low highlands, small and large cities are 20%, 1%, 6% and 9% of all food consumptions respectively(Abate, 2019b).

In Ethiopia, wheat is exported to and imported from abroad for gaining the advantage; but the importing and exporting quantity and value are unbalanced. Currently importing wheat and distributing to millers in subsidized form is to stabilize the wheat price and finally to terminate it by producing and selling more (Tadele et al., 2017).

### 2.1.8Benefits of Agricultural Commercialization

The benefits of commercialization are multidimensional. Commercialization plays a significant role in increasing incomes and encouraging rural growth, through improving employment opportunities; increasing agricultural rural productivity; direct income benefit for employees and employers; expanding food supply and potentially improving nutritional status. In most cases, these increased incomes have led to increased food consumption and improved nutrition (Minde, 2020).

Another benefit of agricultural commercialization goes to its role in the transformation of subsistence agriculture in to market orientated production. Since the 1980s, smallholder commercialization has received greater attention as part of the agricultural transformation process and as a consequence of urbanization and economic growth(WB, 2008). Many regions in the developing world that produce commercial harvests for domestic or export markets are better off than regions that are under subsistence production. The poor in the commercial regions are habitually better paid and have more secure jobs(Binswanger & Braun, 1991).

As the result of Gebremedhin & Tegegne(2012), indicates commercialization plays a significant role in increasing incomes and stimulating rural growth, through improving employment opportunities; increasing agricultural rural productivity; direct income benefit for employees and employers; expanding food supply and potentially improving nutritional status. Smallholder agriculture is also an important factor supporting social and political stability for the reason that it contributes for food supply and nutrition (Poole, 2017).

According to (Samuel & Sharp, 2007) agricultural commercialization is a bridge through which smallholder farmers are able to achieve welfare goals. They describe farm household welfare to represent consumption of basic food (grains), high value foods (livestock products), expenditure on clothes and shoes, durable goods, education and health care. They also note that greater

engagement in output markets would result in higher agricultural productivity which is, in itself an intermediate outcome rather than a welfare goal. However, agricultural productivity can facilitate the accomplishment of the welfare goals of smallholder farmers.

### 2.1.9 Factors Affecting Success of Commercialization of Smallholder Farming

Commercialization of smallholder farming can get ahead its objectives and convey about the vital paybacks to the poor and rural based households when definite factors influencing its potential success or those that affect a farm household's decision to participate in the market are properly managed.(Zhou et al., 2013) classifies five factors which cause smallholder commercialization. These are factors which factors increase demand for agricultural products, push for renewed approaches to farming, make the operating environment more enabling, make operations more efficient and factors making individuals more committed to commercial activities.

Factors affecting commercialization include effective institutions, improved infrastructure, knowledge management, adequate incentives, stakeholders' advantages and a favorable and enabling environment encourages commercialization whereas, weak research and extension system, weak financial system, poor infrastructure and vulnerability discourages it. Policies, public goods and services, subsidies and investment incentives are also some of the critical enablers to facilitate or promote the success of commercialization(Goletti et al., 2003).

On the other hand, informal institution has strong influences on smallholder production and marketing decisions(Lampé, 2006). Informal institutions is associated with traditional, informal organizations at the community level include funeral groups (iddir), worker labor-sharing groups (dabo), oxen or land-sharing groups (mekenajo), and rotating savings and credit associations (iqub). Decision making behavior of individuals is influenced by personal capability and by social and family factors. This implies that informal institutions play a vital role in promoting smallholder commercialization in a sustainable way in the case where intervention made by any of formal institutions is not yet continued (Afework & Endrias, 2016).

With regard to this, Ethiopia has adopted commercialization of smallholder agriculture as a strategy for its economic transformation. For instance, the government has prioritized commercialization of farming as a policy agenda since 2005 and this priority is demonstrated by

the central place in the second five year (2005/06-2009/10) Poverty Reduction Strategy Paper (PRSP) called the Plan for Accelerated and Sustainable Development to End Poverty (PASDEP). As a result the nation recorded encouraging growth during the project life(Dube et al., 2019).Furthermore, the Ethiopia's Growth and Transformation Plan I (GTP I 2010/11-2014/15) and Growth and Transformation Plan II (GTP II 2015/16-2019/2020) retained agricultural sector growth and as the leading driver of economic growth.

## 2.2 Review of Empirical Literature

There are a several empirical studies on determinants of the commercialization of agricultural commodities. For example, a result of Heckman two-stage model conducted by Kyaw et al., (2018), in Magway regions of Myanmar points out age, household size, total income of households, ownership of livestock and distance to market affects commercialization negatively whereas, educational status of household, total product, market price, membership of farmers organization, road condition, access to extension and access to market information affects positively. The researcher recommends that the Myanmar government and policy maker's requisite to create balanced policies for smallholder farmers and manage them properly.

A study conducted by Ahmed (2017), on the impacts of commercialization in smallholder farmers in Bangladesh analyzed by pearson's correlation and regression analysis revealed that, a significant positive relationship between commercialization and household welfare with key variables of market access and internal farming activities which enhances household income and farm outputs. The paper undertakes that improving modern technology and focusing market oriented products progresses welfare and commercialization of smallholder farmers. Thus, the study suggests that government can furnish the farmers with essential technical knowledge and purposes to commercialize their firms and so, farmers will achieve enhanced welfare outcomes. The study used simple correlation analysis to analyze the impact of commercialization which is poor model for impact analysis.

A study conducted on the determinants of commercialization and its impact on the welfare of smallholder rice farmers by using Heckmans' two-stage approach in Pakistan show that gender of the household head, age, number of family member who assist in farming, household size, and the farmer being landlord and farm size were the major determinants of market participation. The welfare of the farmer depends whether the farmer participate in the rice output market. The result also indicated that rice output, off-farm income, access to credit, and income from the sale of rice were important factors persuading the welfare of the household(Rabbi et al., 2017).

The result of a study of Awotide et al., (2016), used Tobit and Heckman two-stage model in Nigeria indicates that gender, yield, years of formal education, access to seed and cost of seed increases the probability of market participation of farmers where, Welfare of the farming households is affected by yield, income and education of the household head. The paper founds that market participation increases household welfare. Therefore, the researcher recommends formation of farmers association, accessing seed and availing market information.

A study conducted by Mpombo(2018), used Tobit and double hurdle model shows a negative impacts of age, gender, household size, marital status, secondary education and market distance on the commercialization decision of households though, primary education, extension market services, wealth index, harvest quantity and pre-harvest loss positively affects commercialization. The researcher suggests Tanzanian governments that, giving more extension service to elder households, provide training and seminars and construct road for farmers.

In addition to this, a study conducted by Camara (2017) in Guinea stated that age, share of off-farm workers in the household, share of dependents in the household, ownership of livestock, market price and use of rain fed system negatively determines market participation of households while, gender, land size, membership of farm organization and hiring agricultural labor positively determines commercialization. Further the paper also revealed positive impacts of commercialization on income of households. The result was analyzed by using endogenous switching model. Improvement of transportation infrastructures and enhancements of farm productivity by facilitating (improved seed, fertilizer, promoting irrigation) can help to improve the agricultural management process.

Girma (2017), conducted a study on determinants of smallholders wheat commercialization in Gololcha district of Bale zone by using multiple linear regression model reveals that cash expenditure for farming, access to credit and total wheat produced were found to influence volume of wheat sold/commercialized/ positively and significantly and Education status and oxen owned had shown negative and significant relationship with volume of wheat sold/commercialized. Thus, the researcher recommends that give attention to new technology, advice on the use of modern inputs and improve market and marketing system.

Another study conducted by (Hassen et al., 2020)on the determinants of market participation among teff producers in Horo Buluk district of Oromia analyzed by double hurdle model shows that, age, educational status of the household head, perception of farmer on lagged teff market price, number of oxen, chemical fertilizer used, cooperative membership, farm size allocated to teff and family size were significantly influence the participation in teff sales considerably. Thus, the researcher recommends enhancing rural education system and family planning program.

The results of Heckman two-stage model indicates, market participation decision of households positively affected by size of land holding, availability of family labor force, education status of household head, accessibility of credit service and access to market price information although, size of family member, being female household and distance to market place depress probability of Teff farmer market participation decision. The researcher recommends providing rational credit service; strengthen community based producer groups and initiating the females socially and economically in the community(Dawana et al., 2018).

A study conducted by Tadele et al., (2017), in four major wheat producing regions of Ethiopia (Amhara, Oromia, Tigray and SNNP) revealed that 27% of overall commercialization of wheat with the highest 41% in Oromia and lowest 17% in Tigray region. The result of Tobit model also stated education level of household head, ownership of livestock, annual wheat production and access to credit positively affects wheat commercialization while, family size and distance from the market affects negatively. The paper suggests improving access to education and credit, increasing annual level of wheat production and increasing livestock holding.

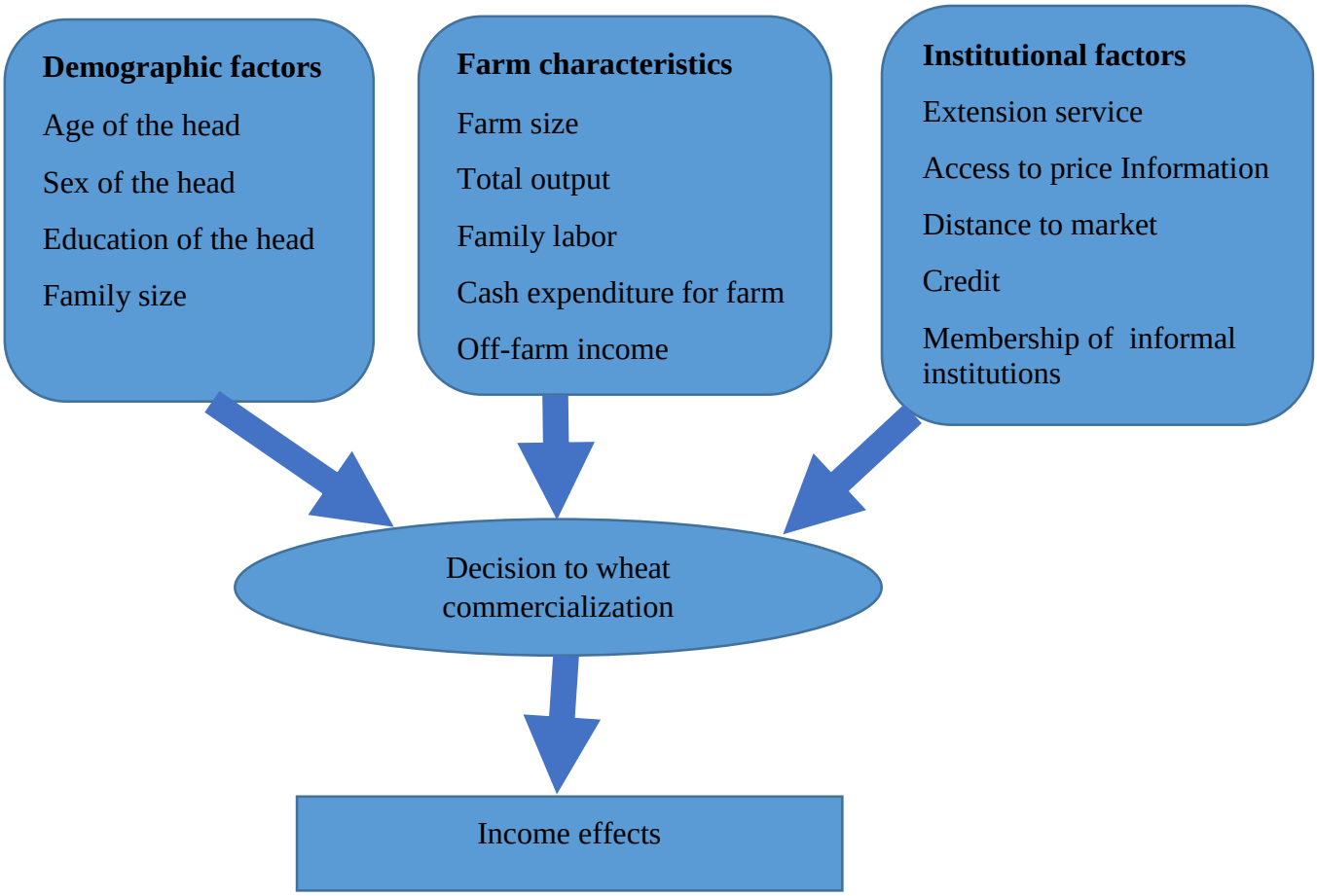
A study conducted by Asmare & Muche(2019), in east and west Gojjam zone analyzed by binary logistic regression points out farm size, education, training, access to extension, access to irrigation, access to private transportation, access to market information and price volatility have statistically significant and positive effects on commercialization of agricultural products although, marital status, family size and off-farm income affects negatively. The result revealed infrastructural, markets and socioeconomic determinants of smallholder farmer commercialization and suggests providing farmers education, adjusting family planning , facilitating farm size, providing training, addressing access to extension, access to irrigation, access to private transportation and access to market information.

The beta regression result of the study conducted at Debre Elias woreda on determinants of wheat commercialization among smallholder farmers indicated that educational status, number of oxen, land size allocated to wheat production, farming experience in wheat production, extension service, and market distance are major factors for smallholder farmer's wheat commercialization whereas, sex of household, dependency ratio and market distance negatively affects. The study also indicates majority of the farmers in the study area are semi-commercial. Giving priority to significant explanatory variables (Endalew et al., 2020).

## 2.3 Conceptual Framework

The basis for this conceptual framework were the work of major actors cited in theoretical and empirical section above. A review of this theoretical and empirical materials gives intuitive evidence for conceptual framework of the study. Demographic and socio-economic factors affecting market participation of farmers include gender, age of household head, education status, household size, and size of farm land hold, off-farm income of the household, total output, cash expenditure for farming and family labor. Then again institutional factors like extension services, distance from the market, access to credit service and access to market information determine the participation and degree of commercialization in output market.

Figure 2.1 Conceptual framework




Source: adapted and modified from (John, 2015)

# CHAPTER THREE

# 3. MATERIALS AND METHODOLOGY

This chapter presents the methodological parts of the paper. It incorporates description about the study area, the research design and strategy, method of data collection, sampling frame and sample sizes and sample collection techniques. Method of data analysis, model specifications, variable description and hypothesis are also the parts of this chapter.

## 3.1 Description of Study Area

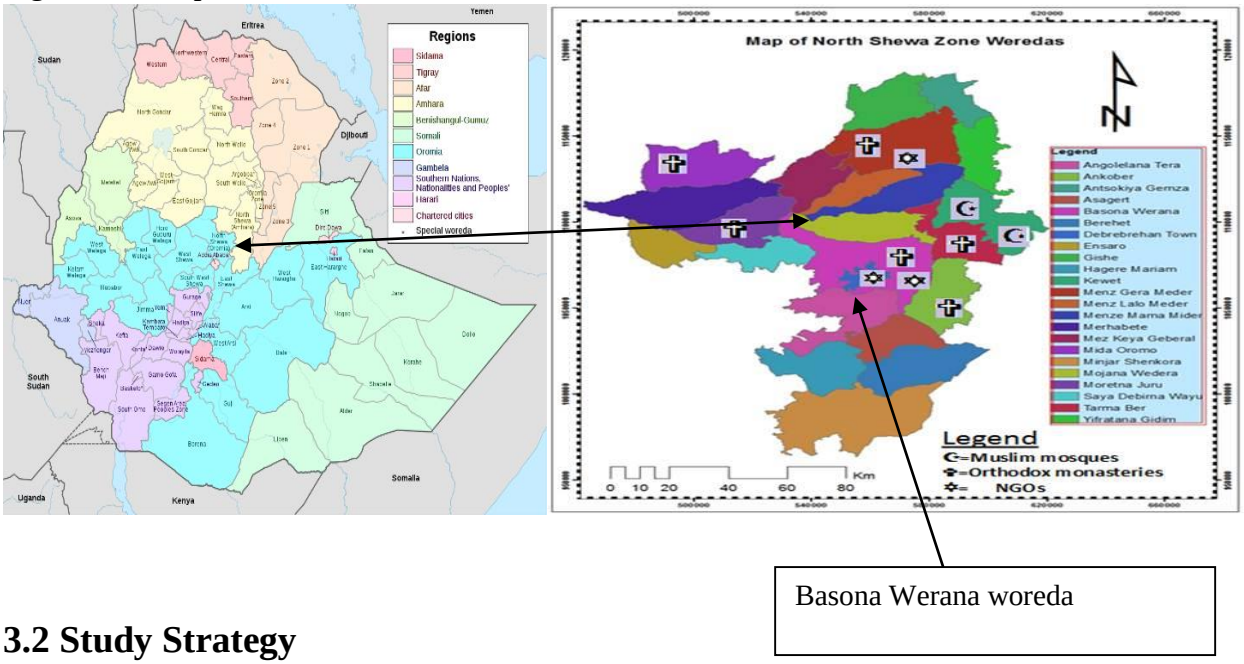
The study was conducted in Basona Werana districts (woredas) of North Shewa zone, Amhara region of Ethiopia. It is located 150 kilometers far from Addis Ababa, capital city of Ethiopia. North Shewa zone is one of 10 zones in the Amhara region. The zone is bordered on the south and the West by the Oromia region, on the north by South Wollo, on the Northeast by the Oromia zone and on the East by the Afar region. The zonal capital is Debre birhan city and the zone has 23 districts (woredas). Basona Werana Woreda was originally named Debre Birhan zuria, the name was used in in the 1994 national consensus, until it changed to the current name Basona Werana. The battle of Segale was fought on 27 October 1916 in this woreda.

Basona Werana district is one of the 23 districts in North Shewa zone. The district was bordered on the south by Angollala terara, on the southwest by the Oromia region, on the west by Siyadebrina Wayu, on the northwest by Moretna Jiru, on the northeast by Termaber and on the east by Ankober. Zonal capital town Debre Birhan is enclaved in this district. Towns in this woreda include Keyit and Gudoberet.

Based on the 2007 national consensus conducted by central statistical authority this woreda has a total population of 120,930 an increase of 7.81%over the 1994 census. With an area of 1,208.17 square kilometers Basona Werana has a population density of 100.9 which is less than the zone average of 115.3 persons per square kilometer (CSA, 2007).

The woreda has 30 kebelles with a total population of 141,059 currently and 42,828 hectares wheat produced lands in 2020 production year. The largest ethnic groups reported in the Basona Werana were Amhara (99.46%) and Amharic was spoken as a first language. The Majority of the inhabitants practiced Orthodox Christianity 99.96% (NSHZ, 2021). The woreda was known by its coldest air condition and wheat production.

Figure 3.1: Maps of the location




## 3.2 Study Strategy

Both quantitative and qualitative research strategy were employed to analyze the data that was collected by using structured household survey questionnaire from a representative samples selected from four sub districts (kebelles) of Basona Werana district.

## 3.3 Research Design, Method and Data Collection

The research design that was used in this study is the cross-sectional design. Accordingly, data related to commercialization of wheat was collected and analyzed. Primary and secondary data were employed. Secondary data were obtained from agriculture and rural development of Basona Werana district. Structured household survey questionnaire was used to collect primary data on the demographic and socioeconomic characteristics of smallholders from a representative random sample of household heads in four randomly selected sub-districts of Basona Werana districts.

## 3.4 Sampling Frame and Sample Size

There are 30 sub districts (kebelles) in Basona Werana district. The total household head in the district is 141,059 with 42828 hectares of wheat harvesting land in 2020 production year (ARDO, 2021). Basona Werana district is selected purposively because, it is suitable and potential wheat producing area. The researcher followed a multi-stage sampling process to select the sample respondents for this study. First, the researcher selected four sub-districts by using simple random sampling technique. Accordingly, Bakelo, Keyit, Abamote and Gudoberet are selected as the sample sub districts.

Next, a list of all household heads acquired from the respective agricultural and rural development offices of the respective sub-districts; and there are 3634 wheat producer households in these four kebelles in 2020 production, then the researcher selected 360 household head respondents in total from the four sample sub-districts randomly. Based on the population level of sample kebelles representative wheat producers were selected using probability proportional to size sampling technique from each sample kebelle. The maximum number of respondents determined by using a formula developed by (Yamane, 1967);

$$n=\frac{N}{(1+N(e)^2} \qquad n=\frac{3634}{(1+3634(0.05)^2} \qquad = 360.33 \approx \quad 360$$

Where, n: is a sample size N: is a population size

e: is a level of precision

The following table summarizes the total wheat producer population size, total sample size and actual number of respondents for each sub-district.

Table 3.1: Sample frame and sample size

| No. | Name of kebelles | Total wheat producers household population size | Sample size |
|---|---|---|---|
| **1** | Bakelo | 1,030 | 102 |
| **2** | Keyit | 882 | 88 |
| **3** | Abamote | 754 | 75 |
| **4** | Gudoberet | 968 | 95 |
| **Total** | | **3634** | **360** |

Source: Agriculture and rural development office of the Basona Werana district, 2021

## 3.5 Data Analysis Method

Descriptive and inferential analyzing methods were employed to analyze the primary data that was collected from wheat producer household heads by using structured questionnaire. Descriptive methods such as table, graph, pie chart and percentage were employed to describe and analyze the household level characteristics. In order to check the significance of variables t-test and $Chi^2$ were employed.

**Degree of wheat commercialization:** In determining smallholders' participation in wheat marketing, household wheat commercialization index (HCI) was applied which was proposed by (Binswanger & Braun, 1994). Thus, the household wheat commercialization index (HCI) which is expressed in the ratio of total amount of sold wheat to the produced amount in quintal was employed to determine the level of wheat commercialization. The advantage of using this approach is that it avoids the use of crude distinctions as commercialized and non-commercialized farms (Kassa et al., 2017). It was applied in order to state the first objective of the study. Similar formulas have been recently used by (Ademe et al., 2017; Endalew et al., 2020; Hassen et al., 2020; Mpombo, 2018; Bekele et al., 2017; Tafesse et al., 2020). Thus household wheat commercialization index can be identified as follows:

$$\text{Household wheat commercialization index (HCI)} = \frac{\text{Amount of wheat sold in the market}}{\text{Amount of total wheat produced}} \text{ x } 100$$

Household wheat commercialization index for individual farmers takes a value between 0 and 1 expressed in terms of percentage. A value of zero would signify a subsistence level mainly produced for consumption purpose and a value of closer to 1 indicates commercial level mainly produced for commercialization.

## 3.6 Variables and Model Specification

### 3.6.1 Econometric model selection and specification

In order to carry out the second and third objective of the study double hurdle model was employed and propensity score matching model was used for the fourth objective. Double hurdle model was employed to identify factors that affect household wheat commercialization decision and its intensity; Whereas, propensity score matching model was employed to examine the effects of wheat commercialization on smallholder households income.

**Double hurdle model specification:** There are numerous studies that have seeks to establish the underlying factors for smallholder market participation have modeled the decision as a two-step decision (Abera, 2009; Lampé, 2006; Mpombo, 2018; Mutabazi et al., 2013; Nkunjana & Zantsi, 2018). Therefore, In order to identify the factors affecting commercialization tendencies neither OLS, Probit nor logit model will work. Thus, Tobit, Heckman two-steps, Heckman maximum likelihood, and Double hurdle model are alternatively employed when dealing with limited dependent variable model. This means in order to analysis wheat commercialization participation decision and extent of commercialization, the econometric models mentioned above are possible alternatives. Consequently, necessary tests that confirm which econometric model to use for the analysis were carried out.

The Tobit model proposed by James Tobin (1958), can be used to describe the relationship between non-negative dependent variable and independent variable. However, the model uses to deal with the resulting data that has many zero outcomes resulting into a censored dependent outcome it assumes that the decision to participate and the intensity of participation is made together. In addition to this, the major implication of using the standard Tobit model is that the factors that affect market participation choice and the quantity decision are one and the same, affecting the endogenous variable in a similar manner (Daniele & Samuele, 2019).

Moreover, it is applied in cases where the dependent variable is not observed for some sample households due to censoring and not due to individual decision. This means Tobit specification assume negative values, but will actually take zero for some censored observations. Therefore, all non-commercialized households are interpreted as corner solutions. Despite its restrictions (Ademe et al., 2017; Hailua et al., 2015) used Tobit model to analyze determinants of crop commercialization. Therefore, Heckman two-step model and double hurdle model can be employed to examine factors that influence the wheat commercialization participation decision and intensity of commercialization.

The Heckman two-step sample selection model can be used to determine factors influence participation decision in wheat commercialization and its intensity. This model is used when the household is assumed to make sequential decisions where first they decide to participate in the market and then the extent of market participation subsequently. With this model, the major assumption is that the zero values were majorly perceived due to the household's self-selection where the farmer purposely chooses not to sell its wheat product hence the value zero.

This model account for the non- randomness of the sample due to the fact that self-selection is almost unavoidable. It corrects for the problem by finding the selection term from the first equation by using the full sample probit model where this is followed by supplementary truncation estimation for the selected subsample. The selection term is included in the second equation as a regressor where it corrects the self-selection problem that was in the sub sample. This was called inverse mils ratio (Daniele & Samuele, 2019; Verbeek, 2004).

A hypothesis test for the double hurdle against the Tobit model can be made. The test could be made by estimating three regressions (Tobit model, the truncated regression and the probit models) separately and use a log-likelihood ratio (LR) test. The significant value of likelihood ratio implies the rejection of the null hypothesis that Tobit model is nested in the double hurdle model. Following Greene (2012) the likelihood ratio test of Tobit restriction can be performed as follows;

$$\text{LRstatic} = -2[lnL_{T-}(lnL_{TR} + lnL_{TR})] \quad (3.1)$$

Where LT represents the likelihood of Tobit, LP represents likelihood of probit and LTR represents likelihood of truncated regression.

This test statistic has LRstatic a chi-square distribution with degrees of freedom equal to the number of parameter restrictions made to get the Tobit model

A better improvement of the two model mentioned above would be to use a double hurdle model, also known as a two tier model. This model also assumes that the household has to make two decisions where first it has to cross the hurdle of deciding to participate or not. Then the household will choose on the intensity of participation (Garc, 2013).

Several studies that have employed this model have followed in the major assumption of the model that the factors that affect the first decision are totally different from those that affect the second decision. The additional advantage of the model is that one same determinant is allowed to influence both decisions (to participate and the extent of participation) in a different way (Engel & Moffatt, 2014; Greene, 2002).

This double hurdle model is a relaxation of Tobit model which is a type of a corner solution outcome model. Therefore, in this study Double-hurdle model was employed by using commercialization participation decision as a first hurdle and intensity of wheat commercialization as a second hurdle with set of explanatory variables. So that, in the first hurdle farmers decide whether or not to participate in crop commercialization, then conditional on the participation(y>0) which uses probit model because the dependent variable is binary character. Whereas, the second hurdle which uses truncated regression model estimates the intensity of wheat commercialization i.e. how much quantity of wheat to be sold to the market. Following (Greene, 2002) the model can be specified as follows:

1. Participation equation

$$Y^* = Z_i\delta + u_{i,}\ u_i \approx N(0\ 1) \quad (3.2)$$

$$p_i = \begin{cases} 1 \text{ if } z_i\delta + u_i > 0 \\ 0 \text{ if } z_i\delta + u_i \leq 0 \end{cases}$$

2. Intensity equation

$$Y_i = X_i\beta + \varepsilon_{i,}\ \varepsilon_i \approx N(0, \delta) \quad (3.3)$$

$$Y_i = \begin{cases} Y^* \ if Y^* > 0 \ and \ p_i = 1 \\ 0, \qquad otherwise \end{cases}$$

Where: Y* refers to a latent variable describing households participation decision in wheat commercialization which takes 1 if households wheat commercialization index is greater than zero, and 0 otherwise.

$Zi$=Refers to a vector of explanatory variables explaining the participation decision.

$u_i$ =Refers to random error term.

corr ($u_i$, $\varepsilon_i$) = p refers to unobserved factors affecting participation may or may not affect intensity of participation.

$\delta$ = refers to unknown parameter to be estimated in the model.

$Y_i$ = refers to dependent variable that describes volume of wheat sold after households participate in wheat commercialization.

$\beta$ = refers to unknown parameter to be estimated in the model, and $\varepsilon_i$ and $u_i$ refers to are respective error assumed to be independent and distributed.

The maximum likelihood estimator of double hurdle model (MLE) produces two results which is first and second hurdle. The first hurdle can be obtained from probit estimator. Consequently, the maximum likelihood estimator (MLE) for the second hurdle can be estimated by truncated normal function, the estimation results was identified whether estimations made simultaneously or one regression at a time. On other hand, while using Craggit makes estimation more coherent, use of probit and truncated regression for Double hurdle model would not chang e(Engel & Moffatt, 2014). Furthermore, under the assumption of independent, homoscedasticity, and normally distributed between two error terms (vi and $\varepsilon i$), the Log-likelihood function of the double-hurdle is the summation log-likelihood of probit model and truncated regression model. Therefore, the log-likelihood function for the double-hurdle model that nests a univariate probit model and a truncated regression model is given following Cragg (1997) by:

$$\ln L_i = \sum 0 \ln\left[1 - \Phi(\varphi i' \alpha)\left\langle \frac{Xi'\beta}{\sigma} \right\rangle\right] + \sum_{+} \ln\left[\Phi(\varphi i' \alpha)\frac{1}{\sigma}\phi\left\langle \frac{yi - Xi'\beta}{\sigma} \right\rangle\right] \quad (3.4)$$

Where,

''0'' indicates summation over the zero observation in the sample;

''+'' indicates summation over positive observations

$\Phi$ (.) and $\phi$ (.) Represent standard normal probability and density functions respectively,

$\Phi i$ And $X_i$ represent independent variables for the probit model and truncated regression model respectively, $\beta$, $\sigma$, and $\delta$ are parameters estimated from each model.

The first term the right-hand side denotes the summation over the zero observation in the sample. Whereas the second term on the right-hand side indicates summation over the positive observations.

Moreover, Akaikan information criterions develop by Akaike (1974) to estimate the kullback-Leibler information for selection of the two competing models was also along with likelihood ratio test. It is the relationship between the maximum likelihood which is used in many statistical analyses and the kullback-Leibler information. According to (John, 2016) joint decision criteria of log likelihood test and Akaike's information criteria ((AIC) was employed to determine the rejection or acceptance Tobit model. Thus, he defined Akaike's information criterion (AIC) as follows:

AIC= -2(log-likelihood) +2k_____ (3.5)

Where, K is the number of estimated parameters included in the model, the log-likelihood of the model is derived by separately estimating each competing models readily available in statistical output. Decision rule for this statistical test suggests that the model with the lowest AIC taken as the best model among competing models.

**Propensity score matching:** In this study, PSM model was employed to see the effect of commercialization on outcome variables (income). Propensity score matching (PSM) helps to examine the conditional probability of receiving a treatment given pre-treatment characteristics (Caliendo et al., 2005). The objective of PSM is to find the closest comparison group from a sample of non-participant household and participant household.

$P(X) = P(Z_i = 1 | X_{ij})$ _____ (3.6)

Where Z (0, 1) is an indicator for exposure to treatment (commercialization) and $X_{ij}$ is a matrix of covariates influencing the outcome variable (income). Following (Hailua et al., 2015)binary logit models was used to estimate the propensity scores P(X). The logit model (Gujarati, (2004)can be described as:-

$$\text{Ln}\left(\frac{Pi}{1-Pi}\right) = Z_i = \beta 0 + \sum_{j=1}^{k} \beta 1 Xij + \varepsilon_I \quad (3.7)$$

Where, P is the propensity score, $Xij$ = is a matrix of observed values influencing income of households, based on economic theory and literature review, j is the response category and $\varepsilon i$is the matrix of unobserved random effects.

Only variables that influence simultaneously the participation decision and the outcome variable should be included. Hence, economic theory a sound knowledge of previous research and also information about the institutional settings should guide the researcher in building up the model(Caliendo et al., 2005).

**Outcome variable:** is total annual income

The partial effects for continuous variables to account for the causal – effect can be calculated using quotient rule as;

$\frac{\partial Pi}{\partial Xi}$ = Pi (1-Pi) βj _____ (3.8)

The average treatment effect on the treated (ATT) which is the average difference in outcome between the matched control (non-commercialized) and the treated group (commercialized) was then estimated as follows:

Y = ZY1 + (1-Z) Y0

ATT = E ($Y1 - Y0 \mid Zi = 1$) = E [$\{Y1 - Y0|Zi=1,(X)\}$]

ATT =E[$\{Y1|Zi=1,(X)\} - E\{Y0|Zi=0,P(X)\}$|Z=1] _____ (3.9)

Where, ATT is the average difference in income between commercialized and non-commercialized wheat producing farmers, P(X) is are the propensity scores and Zi is an indicator for treatment which equals 1 if individuals receive treatment (commercialized) and 0 otherwise. There are two important assumptions that need to be satisfied for the PSM model. These are:-

**Conditional Independence Assumption (CIA):** It indicates that outcomes are independent of treatment and conditional on (Xi). This assumption shows that the selection is only depend on observable variables that affect participation decision of households and outcome variables simultaneously (Abadie et al., 2004).

$(Y_i^T, Y_i^C) \perp D|X$_____ (3.10)

**Common Support assumption:** A further assumptions besides conditional independence assumption (CIA) is the common support or overlap condition. The assumption is that P(x) (probabilities) lies between 0 and 1.This restriction implies that the balancing property is performed only on the observations whose propensity score falls in the common support region of treated and control groups. Individuals that lie outside the common support region would be discarded in the estimation of treatment effect(Becker & Ichino, 2002). That is;

$0<P(D=1)|X<1$ (3.11)

Furthermore, there are four commonly matching algorithm, which are nearest neighbor matching (NNM), radius matching (RM), caliper matching (CM) and kernel matching (KM) which use to match the treated and control group. The matching estimator can be done taking selecting criterion like results in insignificant mean differences between the two groups), a model which bears a low pseudo R2 value and results in large matched sample size is a preferable matching algorism(Becker & Ichino, 2010).

## 3.6.2 Variables

### Dependent Variables

**Commercialization participation decision**= It is a dummy variable measured through sales of the wheat crop, which is denoted as 1and if household sale their wheat produce or wheat commercialization index is greater than zero and zero and otherwise. This is regressed in the first hurdle of the double hurdle model used probit model.

**The intensity of wheat sales:** it is the continuous variable measured in terms of the wheat commercialization index since commercialization participation is defined in terms of sales fraction of total output in the case of commercialization. This is the second hurdle of the double hurdle model which produces truncated regression.

**Independent Variables**

**Age:** It is a continuous variable which refers to the age of the respondent at the time of data collection measured in years. A study conducted by (Manjur, 2018)confirmed better experience and wise resource use of older household heads and it reveal positive effect of age on market participation. So, the current study also expects positive relationship between commercialization and age of household. It was incorporated to capture the role of experiences in wheat commercialization.

**Sex:** It a dummy variable refers to gender/sex of the individuals (1 = male and 0 = female).Male headed households, due to their potential crop production efficiency advantages over female headed households, are expected to be more market oriented, and to sell more produce. This may be due to the female headed households are vulnerable to resource constraint like labor, capital and skill for horticultural crops operation(Aman et al., 2014). Thus the variable is expected to positively affect commercialization. It was used to observe the role of gender in wheat commercialization.

**Educational level *(EDN)*:** It is dummy variable and refers to the educational status of the individual at the time of data collection. It categorized into illiterate, primary education, secondary education and above secondary education. According to Asmare & Muche (2019), education has positive significant impact on commercialization. Similarly the current study also expects positive relationship between education and commercialization. It measure the necessity of human capital.

**Family size *(FMSIZE)*:** It is a continuous variable which refers to the member of the individuals to be included in the household (measured in numbers). Household family size had a negative impact on the proportion of sells(Esmael et al., 2017). The current study also expects negative relationship between family size and wheat commercialization. It is mainly used the extent of consumption in wheat commercialization.

**Farm size *(FRMSIZE)*:** It is continuous variable and refers to the amount of land allocated to wheat in 2020 production year which is measured by number in hectares. Farm land size positively influence commercialization decision (Aman et al., 2014; Dawana et al., 2018). It is hypothesized to be positively affecting commercialization. It mainly determines the resource impacts on commercialization.

**Frequency of extension contact *(FREQEXT)*:** It is continuous variable which refers to the availability of extension package which is used for increased agricultural products and facilitating of commercialization which is measured in days within a year. A result of a study conducted by (Kassa et al., 2017; Mpombo, 2018) indicates that, contact was positively associated with households' market participation. In the present study too, the impact of this variable is expected to affect quantity of wheat sold positively. This is because the extension agents are responsible to offer technology, product management and marketing.

**Access to market information *(ACMINF)*:** It is dummy and refers to availability of relevant information regarding how to produce and participate for commercialization activities (1 =available and 0= not available). It has positive impact on market participation of agricultural products for the farmers in the rural areas(Asmare & Muche, 2019). The current study also expects positive relationships. It used to measure market price information.

**Distance from the market *(DSTMKT)*:** It is a continuous variable that measures the total distance from the household resident to the market place measured by kilometers. The study conducted by Hassen et al., (2020), finds a negative relationship between distance to market and commercialization. The variable expected to have a negative effect. It captures transaction cost.

**Off-farm income *(OFFINC)*:** It is dummy and refers to the availability of additional income for the farmers which is dummy variable (1 = available and 0= not available). A study conducted by Asmare & Muche(2019), revealed negative impact of off-farm income on commercialization. The variable expected to have negative impact also on current study. It observe effects of additional income.

**Access to credit (*ACCRDT):*** It is dummy and refers to the availability of credits for small holder farmers to modernizing the agricultural products for market participation which is dummy variables (1= available and 0= not available). Access to credit service increases the production of crops in general wheat production in particular (Endalew et al., 2020). Therefore, the variable is expected to positively affect farmer's wheat commercialization. It captures the role of appropriate facility.

**Family labor *(FMLBR):*** It refers to the availability of family labor participating in wheat production measured in number in a day. According to Abera(2009), family labor size positively affects commercialization. Hence, wheat is a labor intensive product the current study also expects positive effect. It measures effects of labor (input) on commercialization.

**Quantity of wheat produced *(QTYW)*:** It is continuous variable that represent the total amount of wheat produced by the household measured by quintals (1quintal = 100Kilograms). An increase in volume of wheat production has a significant effect on market supply and motivates farmers of to increase the supply of commodity to the market (Tadele et al., 2017). This is because it measures the total output (supply capacity).

**Cash expenditure for farming *(CEXP):*** It is a continuous variable that values the use of modern farm inputs such as fertilizers, improved seeds and pesticides (measured by cash expenditure on the purchase and transport of these inputs, Birr). This variable indicates the use of modern agricultural inputs and the degree of commercialization in input side which are the basic preconditions of output side commercialization. (Gebresselassie and Sharp, 2007)found that cash expenditure on inputs such as fertilizer, pesticides, and peak-season hired labor also significantly affects the total volume of farm output. Hence, this is expected to correlate with quantity of output sold positively. It captures appropriate input utilization capability.

**Feasting *(FEAST*):** It is a dummy variable that represent the celebration of social and religious ceremony such as weeding, sanbate, mahber, birthday, teskar and graduation (1= if household feasts, 0= otherwise). Thus, households use their wheat products for the preparation of party, it is expected negatively affect the commercialization of wheat. It captures unnecessary extravagancies.

**Membership of informal institutions *(INFINS*):** It is a dummy variable that represent the membership of households in informal institutions include idir, equb, share cropping, etc. (1=if member, 0=otherwise). This informal institutions helps members via support during death, sickness, borrowing money for purchasing input, saving money and helping each other during harvesting (Teshome et al., 2008). In other words, social institutions have more power to influence the behavior, decision-making, values and practices of community members (Regassa et al., 2013).

Therefore, the variable expects to positively affect commercialization. This is because it indicates the role of supporting means of informal institutions.

**Outcome variable**

**Net income (*INCOME):*** it is a continuous variable which represents income earned annually (measured in Birr). Income of households was measured by net annual incomes and commercialization increases households income (Hailua et al., 2015; Minde, 2020). Thus, it is hypothesized to be affected positively.

Table 3.2: Summary of variables and their expected effect

| Variables | Type | Measurement | Expected effect |
|---|---|---|---|
| **Independent variables** | | | |
| **Commercialization** | Dummy | Commercialized=1, 0=otherwise | |
| **Intensity of commercialization** | Continuous | Number | |
| **Age of household** | Continuous | Year | +ve |
| **Sex of household** | Dummy | Male=1, Female=0 | +ve |
| **Education level of household** | Dummy | Illiterate=0<br>Primary=1<br>Secondary=2<br>Above=3 | +ve |
| **Family size** | Continuous | Number | -ve |
| **Farm size allocated to wheat** | Continuous | Hectare | +ve |
| **Frequency of extension contact** | Continuous | Days | +ve |
| **Access to market information** | Dummy | Yes=1,No=0 | +ve |
| **Distance to market** | Continuous | Kilometers | -ve |
| **Off-farm income** | Continuous | Birr | -ve |
| **Access to credit** | Dummy | Yes=1,No=0 | +ve |
| **Available Family labor** | Continuous | Number | +ve |
| **Quantity of wheat produced** | Continuous | Quintals | +ve |

| | | | |
|---|---|---|---|
| **Cash expenditure for farming** | Continuous | Birr | +ve |
| **Feasting** | Dummy | Feast=1, No=0 | -ve |
| **Membership of informal institutions** | Dummy | Member=1, 0=otherwise | +ve |

### 3.6.2 Diagnostic Taste

To check the validity of the model the following test was employed:

**Multicollinearity**: This problem arises due to a linear relationship among explanatory variables; and becomes difficult to identify the separate effect of independent variables on the dependent variable because there exists strong relationship among them (Gujarati, 2003). Variance inflation factors (VIF) technique was employed to detect multicollinearity in continuous explanatory variables. The tests used for this purpose was the Variance Inflation Factor (VIF). Therefore, if the VIF value is above 10 the variable is said to collinear.

**Hetroschedasitcity:** Under this, the researcher tested whether the variance remains constant for all observations or not. If there is an existence of hetroschedasitcity problem in the data set, the parameter estimates of the coefficients of the independent variables cannot be BLUE. Therefore, Breusch-Pagan test of hetroschedasitcity which does not require ordering of observations but requires the assumption of normality will be employed for detecting hetroschedasitcity in this study (Greene, 2002).

**Sensitivity test:** Recently checking the sensitivity of the estimated results becomes an increasingly important topic in the applied evaluation literatures. It is applied for propensity score matching model. If there are unobserved variables which affect assignment into treatment and the outcome variable simultaneously, a hidden bias might arise. It should be clear that matching estimators are not robust against this hidden bias because of unobserved factors. So that, the researcher should have to determine how strongly an unmeasured variable must influence the selection process in order to undermine the implications of matching analysis(Caliendo et al., 2005).

To confirm the robustness of the finding of average treatment effect, the post estimation analysis of sensitivity test was checked. Sensitivity analyses tests how strong the influence of unobserved

factors on the participation process. If there are unobserved variables that affect participation decision and the outcome variable simultaneously, a hidden bias might arise to which the average treatment effect are not robust (Becker & Ichino, 2010).

# CHAPTER FOUR
# 4. RESULTS AND DISCUSSIONS

In this chapter, the results of the findings from both quantitative and qualitative data are analyzed and discussed thoroughly followed by the discussion of the respective issues of interest. First, descriptive and statistical analyses of the demographic and socioeconomic characteristics of the sample households are presented. Next, econometric analyses of the determinants of commercialization of smallholder farming households and its effects on households' income are presented.

## 4.1 Descriptive Results

### 4.1.1 Demographic and socio economic characteristics of sample households

This sub-section presents the demographic and socioeconomic features of the 360 sample respondents. The main unit of analysis used was the household head that is said to be responsible for the decisions to be made in the household. t-test for continuous variables and $Chi^2$ test for dummy variables were tested to test the significance of variables. Table 4.1 and 4.2 presents demographic and socio-economic characteristics of the sample respondents with their corresponding statistical tests. The sample population of wheat producer respondents handled during the survey was 360.

**Age**

The findings reported on the table 4.1 shows that the mean age of wheat commercialized farmers was 44.83 and that of non-commercialized farmers was 44.13. The t-test was employed to evaluate the mean age difference between commercialized and non-commercialized households. The result indicated that mean difference was statistically insignificant.

**Family size**

Regarding family size of the respondents the average family size for commercialized and non-commercialized household was 4.90 and 4.95, respectively. The mean difference between family size of commercialized and non-commercialized farmers are statistically insignificant.

Table 4.1 Statistical summary of continuous variables

| Variables | Commercialized | | Non-commercialized | | Total | t-test |
|---|---|---|---|---|---|---|
| | Mean | Std. Dev. | Mean | Std. Dev. | | |
| **Age** | 44.83 | 10.13 | 44.13 | 9.76 | 44.67 | -0.5516 |
| **Family size** | 4.90 | 1.33 | 4.95 | 1.5 | 4.91 | 0.2812 |
| **Total farm size** | 2.03 | 0.56 | 1.5 | 0.42 | 1.91 | -7.9631*** |
| **Cultivated land** | 1.72 | 0.49 | 1.23 | 0.382 | 1.606 | -8.3190*** |
| **Land size allocated to wheat** | 0.69 | 0.28 | 0.3 | 0.13 | 0.6 | -12.1695*** |
| **Frequency of extension contact** | 9.68 | 7.82 | 0.96 | 2.02 | 7.7 | -9.9788*** |
| **Distance from the market** | 4.54 | 2.03 | 5.7 | 3.13 | 4.8 | 3.9479*** |
| **Family labor** | 3.34 | 1.065 | 2.85 | 0.876 | 3.227 | -3.7595*** |
| **Total product** | 12.58 | 5.543 | 4.585 | 1.248 | 10.76 | -12.9603*** |
| **Cash expenditure** | 6829.651 | 3002.235 | 4887.689 | 1474.119 | 6387.32 | -5.6557*** |

Source: own survey, 2021

**Farming Characteristics**

Farming was the main occupation and source of livelihood for all sample producers where the major ones are crop production. Farm characteristics of the respondents was represented by many variables.

**Land size**

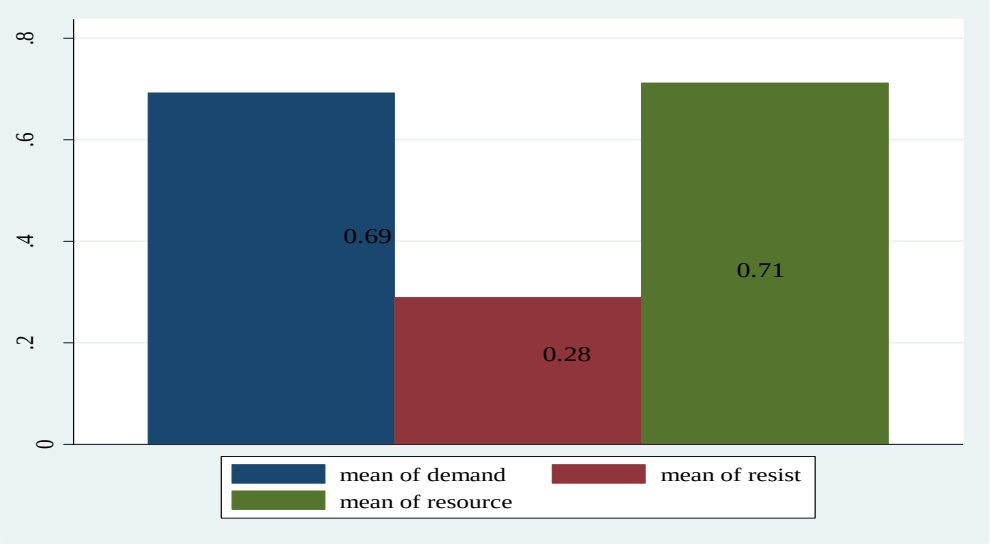
The average total land holding size of households is less than 2 hectares (1.91) with the minimum of 0.25 hectares and maximum of 5 hectares. This visibly shows that most of the households are smallholder farmers as they have access to limited land sizes, less than 2 hectares (Minde, 2020).

The mean of total land size of the commercialized and non-commercialized households are 2.03 and 1.5 hectares, respectively. This implies that the total land size of the commercialized household is higher than non-commercialized households. Hence, one of the most important factors that affect crop production is availability of land for crop production. The result was statistically significant. The mean of cultivated land size of the commercialized and non-commercialized households was 1.72 and 1.23. It is statistically significant. Concerning land size allocated to wheat the average land size of commercialized farmers was 0.69 hectares whereas non-commercialized farmers average land size allocated to wheat is only 0.3. The result is statistically significant (see table 4.1).

**Total amount of wheat produced**

Crop production in the study area was not only for home consumption but also for meeting cash requirements of the producers. Particularly wheat production in Basona Werana Woreda is dual purpose (food and cash crop). Total average wheat product in the study area in 2020 production year was 11.76 quintals. As the result presented in table 4.1 indicated that the mean of total production of commercialized and non-commercialized farmers was 12.58 and 4.585, respectively. This implies that farmers which produce higher output covers its consumption and participates for commercialization. Farmers produce wheat because of three reasons; high demand for wheat in market (69% of them), disease resistance of wheat (28%) of them and their land suitability for wheat harvesting (71%).

Figure 4.1 Reasons of producing wheat of households




Source: Own survey, 2021

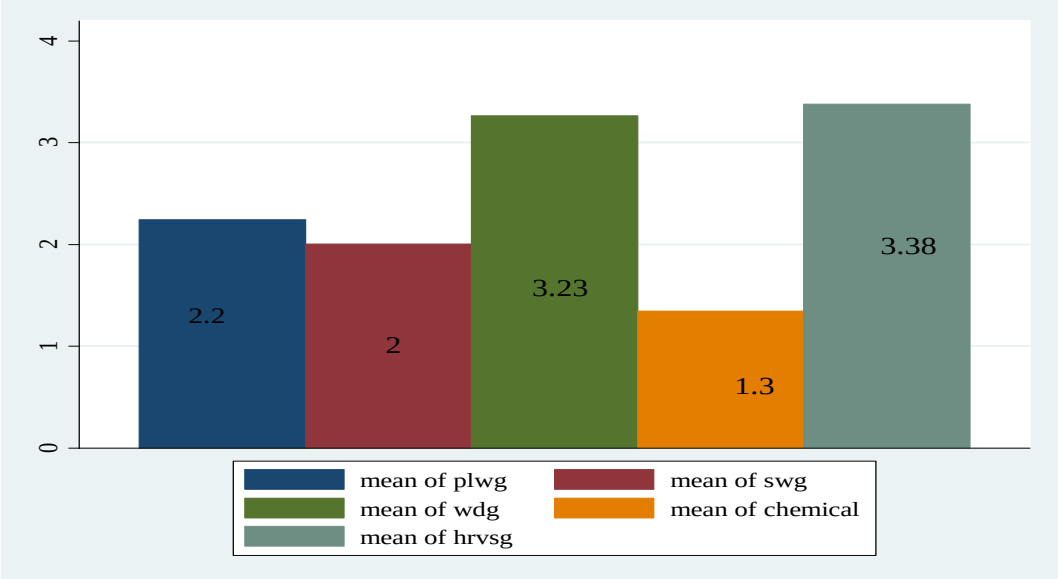
**Total cash expenditure on input**

Regarding average cash expenditure for input utilization of wheat production, commercialized smallholder farmers (6829.651 ETB) were higher than that of non-commercialized (4887.689). This cash expenditure incorporated the expenditure for farming, wage paid for hired labor, seed, fertilizer, herbicide, fungicide up to storage etc. As the survey result indicated the result was statistically significant. This implies that investing in wheat production results in increasing commercialization through better production performance.

**Family labor**

On the other hand, the mean of family labor for commercialized and non-commercialized households was 3.34 and 2.85, respectively. The t-test result revealed significant mean difference between family labor amount of commercialized and non-commercialized farmers. This implies that increasing the amount of labor for wheat harvesting results to increase in production because wheat is a labor intensive product. Weeding and harvesting is the major activity of wheat cultivation process that requires more labor quantities. Out of total respondents only 17.78% of them hired daily wage in 2020 production year for wheat harvesting. The minimum daily labor wage is 100 birr and 140 birr is the maximum in the study area.

Figure 4.2 Family labor compositions




Source: Own survey, 2021

**Market distance**

Moreover, market distance is the most important variable to determine smallholder farmers' participation in the market to sell their product. Market distance used to measure the transaction costs of wheat product offering to the nearest market. According to the survey result from the table 4.1 the mean distance from the nearest market commercialized and non-commercialized farmers were 4.54 and 5.7 kilometers, respectively. Its t-test statistic was significant.

**Sex**

The survey result presented in table 4.2 indicated that about 76.67% of smallholder farmers were male headed households and 23.33% of them were female headed households. The survey result presented in table 4.2 indicated that 17.78% and 5.56% of female households are commercialized and non-commercialized households, respectively. On the other hand, 59.44% and 17.22% were commercialized and non-commercialized male headed households. The Chi-square test result revealed that there was no significant association between sex and wheat commercialization.

**Educational status**

Concerning educational status of households' 52.5% of the households were illiterate. This implies that majority of them were unable to read and write. Out of commercialized farmers 42.22%, 31.39% and 3.61% of them were illiterate, primary and secondary education attended households. Whereas 10.28%, 10.28 and 2.22 % non-commercialized households were illiterate, primary and secondary education attended, respectively. The result was statistically insignificant.

**Participation of off-farm income**

Moreover, in addition to the farming activities, some respondents (46.67%) have also engaged in non-farm activities like petty trading, fire wood selling, house renting and daily labor and earn additional non-farm income of on average is 2125.9 birr per year. Out of off-farm activity participant farmers 35.06% of them were commercialized farmers and 11.39% were non-commercialized.

**Institutional factors**

Institutional services are critical precondition for enriched wheat commercialization. More specifically, access to market information, access to credit and access to extension contact are the most important services in the enhancement of wheat commercialization and thereby increase income of the farmer (Girma, 2017).

**Market information**

Regarding output market price information service 90.83% of the respondents got the information where 73.06 of them were commercialized and 17.78% were non-commercialized farmers. Majority of the wheat price information sources were market participant farmers, neighbor, friends and traders. This points out that the use of modern communication mass media like radio, television and newspapers was missing. The Chi-square test result revealed that output market price information and commercialization has statistically significant association.

**Transport access**

Modern transport access is one of very important infrastructural tools help for commercialization. According to the survey result presented in table 4.2, 69.72% and 21.67% commercialized and non-commercialized farmers were beneficiary of modern transport access. The Chi-square result revealed insignificant association between modern transport access and commercialization.

**Extension Contact**

The survey result indicated in table 4.1 showed that the mean of extension for commercialized farmer was 9.68 days contact in a year whereas non-commercialized farmers contact 0.96 days in average. Amhara region agricultural office through its development agent (DA) was the major actor who provides information and advisory service on wheat production and management practices. Further, model farmer's and neighbor farmers/friends were also mentioned as source of information, advice and experience. Extension service user gets knowledge/information of input use, crop management, product marketing and credit use.

Table 4.2 Summary statistics of dummy variables

| Variables | Category | Commercialized Number (%) | Non-commercialized Number (%) | Total Number (%) | Chi2 |
|---|---|---|---|---|---|
| **Sex** | Female | 64(17.78) | 20(5.56) | 84 (23.33) | 0.0663 |
| | Male | 214(59.44) | 62(17.22) | 276(76.67) | |
| **Education status** | Illiterate | 152(42.22) | 37(10.28) | 189(52.5) | |
| | primary | 113(31.39) | 37(10.28) | 150(41.67) | 4.2065 |
| | secondary | 13(3.61 | 8(2.22) | 21(5.83) | |
| **Availability of market price information** | Yes | 263(73.06) | 64(17.78) | 327(90.83) | 20.8442*** |
| | No | 15(4.17) | 18(5) | 33(9.17) | |
| **Modern transport access** | Yes | 251(69.72) | 78(21.67) | 329(91.38) | 1.8804 |
| | No | 27(7.5) | 4(1.11) | 31(8.61) | |
| **Participation of off-farm income** | Yes | 127(35.28) | 41(11.39) | 168(46.67) | 0.4740 |
| | No | 151(41.94) | 41(11.39) | 192(53.33) | |
| **Access to credit** | Yes | 78(21.67) | 7(1.94) | 85(23.61) | 13.3786*** |
| | No | 200(55.56) | 75(20.83) | 275(76.39) | |
| **Preparation of feasting** | Yes | 173(48.06) | 62(17.22) | 235(65.28) | 5.0011** |
| | No | 105(29.17) | 20(5.55) | 125(34.72) | |
| **Membership of informal institutions** | Yes | 274(76.11) | 62(17.22) | 336(93.33) | 53.6079*** |
| | No | 4(1.11) | 20(5.56) | 24(6.67) | |

Source: Own survey, 2021

**Credit service**

Regarding credit use of farmers only 23.61% of them were beneficiary where 21.67% of the users were commercialized farmers. Whereas 55.56% and 20.73% of non-users were commercialized and non-commercialized farmers, respectively. The Chi-square result indicated that there is significant association between credit use and wheat commercialization. Out of total credit users 21.39% of them spent it for purchasing of inputs used for wheat harvesting including improved seed and fertilizer. Amhara saving and credit association is major source of credit for 22.5% of borrowers followed by microfinance (1.11%).

As a precondition to credit 16.67% of them were asked for personal guarantee whereas 5.56% of them use their land as guarantor and 1.39% of them were borrowed because of their membership in the saving and credit association. High interest rate was a major problem to both credit users and nonuser in the given year (81.67%). On the other hand, 10% and 8.33% of the respondents face the problem of restrictive procedures of getting credit and unfavorable repayment period, respectively.

**Feasting**

In our country Ethiopia, feasting is one of our well known cultures. It may be cultural or religious celebration programs. Peoples feast for weeding, school graduation, birth day, teskar (‘mass’ called by Catholics), sanbate and mahber/commonly celebrated by orthodox Christians/, christening/Orthodox Christians/, sedeka /muslims/, etc.

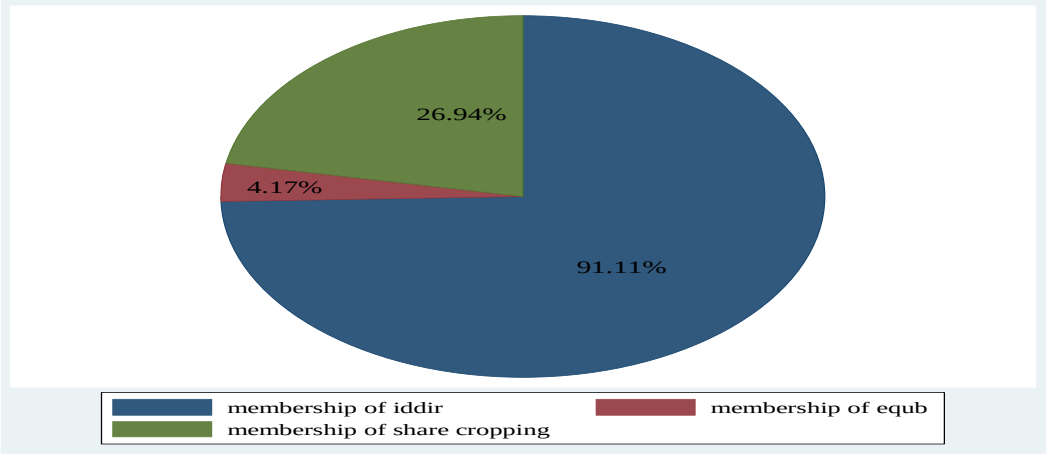
In Basona Werana district in average 65.28% of farmers were prepared feast in a given year and about one quintals of wheat was spent for the program. Out of total sample respondents 46.11% of them feasts for mahber/ sanbate followed by 8.06% teskar, 8.33% birthday, 4.72% graduation and 3.33% feasts for wedding. As table 4.2 indicated that 48.06% of feaster households were commercialized and 17.22% of them were non-commercialized. Out of 34.72% of non-feaster households 29.17% of them were commercialized and 5.55% of them were non-commercialized. The Chi-squared result revealed significant association between feasting and commercialization.

**Membership in informal institutions**

Informal institutions are schemes of rules and decision-making procedures which have grown from endogenous sociocultural codes and give rise to social practices, dispense roles to participants and guide interactions (Regassa et al., 2013). Some of the most commonly experienced informal institutions in the study area includes iddir, ekub and sharecropping. This used the community as insurance during death, share cropping during harvesting and play significant role in production and commercialization. In this survey 93.33% of the respondents are members of informal institutions. Where 91.11% of them were members of iddir which used to help each other during death. According to Regassa et al., (2013), the inventive purpose of the iddir was to provide the financial wherewithal for the funeral of the dead, but it has advanced into an association that offers a multitude of services for its members. These services include financial, material, social and psychological sustenance.

Share cropping is a practice of helping each other by term during ploughing, weeding and harvesting crop. Equb seems like a traditional bank, saving money together and taking the money they saved in a lottery method. Out of total informal institution members' 76.11% and 17.22% households are commercialized and non-commercialized, respectively. The Chi-square result revealed significant association between informal institution and wheat commercialization.

Figure 4.3 Informal institution membership composition of households




Source: Own survey, 2021

**Input use**

Input application was one of the most essential agricultural practices that are used by wheat producers in the study area. Besides, appropriate application of the suggested input rate is important to attain the required quality and quantity produced thereby increasing quantity of market supply (Anteneh & Asrat, 2020).

**Improved seed**

According to the survey result only 29.72% of the respondents use improved wheat seed where 26.11% of them were commercialized farmers. The Chi-square result revealed significant association between using improved seed and wheat commercialization. In average commercialized farmers used 53.24 kilograms of improved seed per hectare whereas non-commercialized farmers used 18.292 kg per hectare which implies that using improved wheat seed results increase in commercialization through increased production level. The minimum price is 3000 birr per 100kg whereas the maximum is 3400 birr per 100kg. Most of improved seed users bought the seed from farmers union (22.78%).

**Fertilizer**

Regarding fertilizer used for wheat production urea and dap were applicable by all of the respondents but, the amount applied per hectare was different. As the evidence indicated in table 4.4 show that the average of amount of urea used per hectare was 110.36 kg and 95.67 kg by commercialized and non-commercialized farmers, respectively. The minimum price for urea per kg is 1350 birr and maximum price is 1800 birr per 100kg.

Commercialized farmers used 118.7kg dap per hectare in average whereas non-commercialized used 97.93kg per hectare. The minimum price was 1350 birr per 100kg and the maximum price is 1720 birr per 100kg. There is no significant association between commercialization and urea and dap application. However, the mean difference of amount of urea and dap used per hectare was significant (see table 4.3 and 4.4). This implies that applying appropriate amounts of urea and dap for wheat harvesting process leads to better result in commercialization. The sole supplier of urea and dap was farmers union.

Table 4.3 Summary of input use

| Variables | Category | Commercialized Number (%) | Non-commercialized Number (%) | Total Number (%) | Chi2 |
|---|---|---|---|---|---|
| **Improved seed** | Yes | 94(26.11) | 13(3.61) | 107(29.72) | 9.7777*** |
| | No | 184(51.11) | 69(19.16) | 253(70.28) | |
| **UREA** | Yes | 278(77.22) | 82(22.78) | 360(100) | |
| | No | - | - | - | |
| **DAP** | Yes | 278(77.22) | 82(22.78) | 360(100) | |
| | No | - | - | - | |
| **Herbicide** | Yes | 277(76.94) | 82(22.78) | 359(99.772) | 0.2958 |
| | No | 1(0.28) | 0 | 1(0.28) | |
| **Fungicide** | Yes | 269(74.72) | 73(20.28) | 342(95) | 7.9826*** |
| | No | 9(2.5) | 9(2.5) | 18(5) | |

Source: Own survey, 2021

Among total wheat producer farmers 99.772% of them used herbicide in 2020 production year when, 76.94% and 22.78% of them were commercialized and non-commercialized farmers, respectively. The mean of amount of herbicide applied per hectare between commercialized and non-commercialized famers was 0.981 and 0.99 liter. The t-test result indicated significant mean difference. Herbicide reduces the load of weeding by labor force. Fungicide helps to protect the wheat harvest from the disease caused by funguses. Total of 95% of respondents used fungicide in 2020 production year when, 74.72% of them were commercialized farmers. The significant mean difference between commercialized and non-commercialized farmers was 0.98 and 0.896 liter. Private traders were the major supplier for herbicide and fungicide which covers 87.22% and 92.78%, respectively.

Table 4.4 Summary of amount of input used per hectare

| Variables | Commercialized | | Non-commercialized | | Total mean | t-test |
|---|---|---|---|---|---|---|
| | Mean | Std. Dev. | Mean | Std. Dev. | | |
| **Amount of improved seed (Kg)** | 53.24 | 78.273 | 18.292 | 43.399 | 45.28 | -3.8686*** |
| **Amount of UREA (Kg)** | 110.36 | 31.12 | 95.67 | 18.92 | 107.01 | -4.0578*** |
| **Amount of DAP (Kg)** | 118.27 | 38.71 | 97.93 | 15.73 | 113.64 | -4.6442*** |
| **Amount of herbicide(liter)** | .981 | 0.098 | 0.99 | 0.047 | .984 | 0.8361 |
| **Amount of fungicide (liter)** | .980 | 0.136 | 0.896 | 0.302 | 0.961 | -3.5704*** |

Source: Own survey, 2021

**Income status of households**

Households' annual income is the annual earning of household's which includes income gained form wheat commercialization, off-farm income participation, livestock and the like. Annual income also represents welfare and livelihoods of the households'. According to the evidence from the table 4.5 commercialized households earn about 30244 ETB annually whereas non-commercialized farmers earn about 20213 ETB on average. The t-statistic result revealed significant mean difference between annual income of commercialized and non-commercialized annual income of households. Therefore, participates in wheat market helps to enjoy better living standard for smallholder farmers.

Table 4.5 Summary of income status of households

| Variables (ETB) | Commercialized | | Non-commercialized | | Total mean | t-test |
|---|---|---|---|---|---|---|
| | Mean | Std. Dev. | mean | Std. Dev. | | |
| **Income** | 30244.24 | 11549.57 | 20213.41 | 7957.66 | 27959.44 | -7.3625*** |

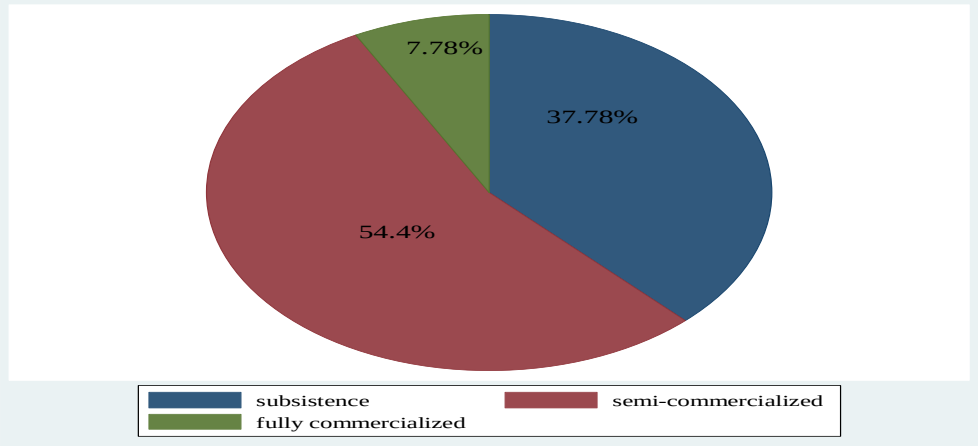
Source: Own survey, 2021

### 4.1.2 Level of commercialization

Commercialization had been divided into three categories: Low/ fully subsistence with the commercialization index of ≤30%, Medium/ semi-subsistence 30–75% and High/ fully-commercialized >75% (Brempong et al., 2013). Following this, more than half of the smallholder farmers are semi-commercialized (54.4%). This indicates that out of their total harvest, a proportion is consumed at home while the rest is sold.

Then, about 37.78% of them are fully subsistence. This denotes that they consume all of their total harvests. The rest 7.78% of the smallholder farmers are fully commercialized. This can be described by the fact that they sell the full proportion of their harvest to the market. The overall HCI indicates that about 51% of the harvested wheat output is sold which is semi-commercial. The result was in line with (Endalew et al., 2020)

Figure 4.4 Level of household's wheat commercialization




Source: own survey, 2021

## 4.2 Inferential Statistics: Results and Discussion

This subsection presents the results of econometric analysis of the determinants of households' wheat commercialization decision with the binary logistic model, and the welfare impacts of wheat commercialization with propensity score matching model. Though, before running the regression the diagnostic tests such that, the existence of multicollinearity, the problem of hetroschedasitcity, sensitivity and the normality distribution of residuals are needed to be checked.

### 4.2.1 Diagnostic tests

**Multicollinearity:** Multicollinearity is an econometric problem where there is a high linear relationship between one or more explanatory variables in a regression model. Multicollinearity affects cross sectional data, although the effect varies depending on the extent.

The effects of high correlation between explanatory variables is that the model estimates could have unexpected sign, unreliable standard errors and artificially wide confidence intervals that would lead to accepting the null hypothesis, which would have been otherwise rejected(Gujarati, 2004). The tests used for this purpose was the Variance Inflation Factor (VIF). The results of VIF conducted were presented below on table 4.6. The average VIF of the explanatory variables used is given as 1.92 less than 10, which indicates that the model is free from multicollinearity problem.

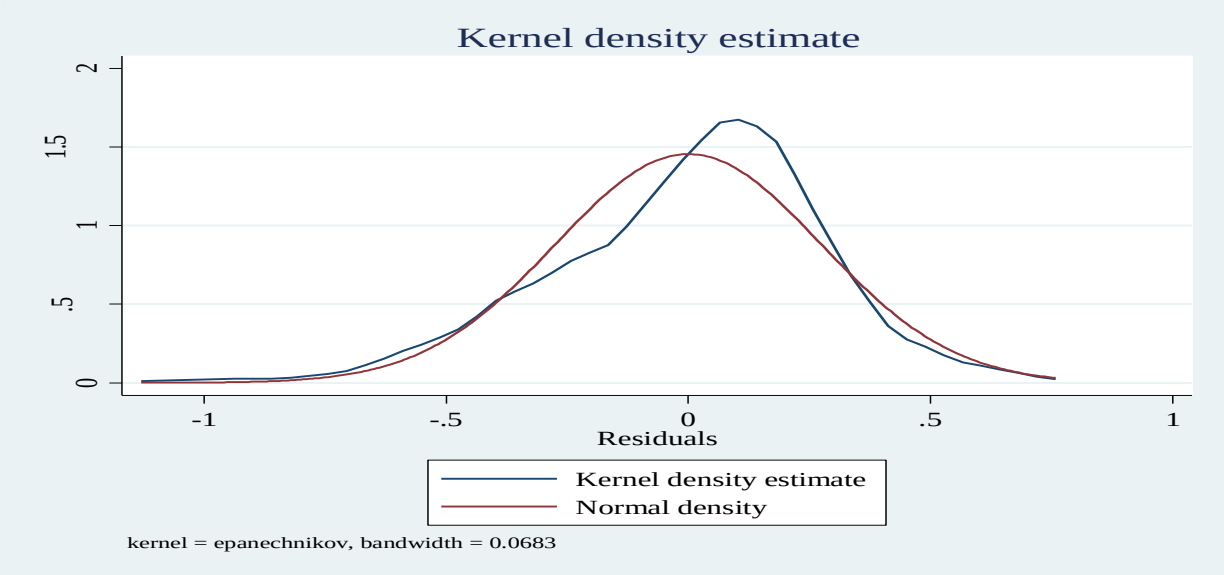
Table 4.6 Results of multicollinearity test

| Variable | VIF | 1/VIF |
|---|---|---|
| **Total wheat produced** | 5.25 | 0.190327 |
| **Farm size (log)** | 4.07 | 0.245445 |
| **Frequency of extension contact** | 2.96 | 0.337403 |
| **Family size** | 2.42 | 0.413008 |
| **Family labor** | 2.17 | 0.461833 |
| **Age** | 1.55 | 0.644831 |
| **Cash expenditure for input** | 1.54 | 0.648371 |
| **Distance from the market** | 1.16 | 0.861284 |
| **Sex** | 1.13 | 0.888178 |
| **Access of market price information** | 1.13 | 0.888697 |
| **Education status** | 1.11 | 0.897522 |
| **Membership of informal institutions** | 1.09 | 0.918536 |
| **Access of credit service** | 1.07 | 0.937734 |
| **Preparation of feast** | 1.06 | 0.943458 |
| **Participation of off-farm income** | 1.05 | 0.956585 |
| **Mean VIF** | 1.92 | |

Source: own Survey, 2021

**Normality test:** This test is concerned to check the disturbance terms are normally distributed or not. It can be conducted either graphical plot or numerically through commands. In this study, the kernel density estimation was used, which plot the residuals. If the residuals are normally distributed, the kernel density plot should be bell-shaped and approach to normal density curve. Figure 4.5 below shows that kernel density plotted for the residuals. According to the below graph the error term was almost normally distributed since the kernel density curve is almost approaching to normal density function.

Figure 4.5 Normality test




Source: Own survey, 2021

**Hetroschedasitcity test:** The problem of hetroschedasitcity is always common and expected when analyzing cross-sectional data. This is because observations are all the same in time period but are from different entities (Gujarati, 2004). So that, the existence of hetroschedasitcity was tested by employing Breusch- Pagan test using STATA command hettest. The result stated below shows the presence of hetroschedasitcity hence, the probability of rejecting null hypothesis is 0.000.

Breusch-Pagan / Cook-Weisberg test for hetroschedasitcity

Ho: Constant variance

Variables: fitted values of commerc.

$chi^2(1)$ = 29.62 Prob> chi2 = 0.0000

To correct the hetroscedastic data, the researcher used robust (hetroschedasitcity consistent) standard errors.

### 4.2.2 Determinants of the Decision to participation for wheat Commercialization

The possible econometric model estimated to be employed in the analysis of wheat commercialization participation decision and intensity where the Tobit model, Heckman two-step, and double-hurdle model. Therefore, it is very important to identify which econometric model to use when dealing with such kinds of the problem. Likelihood ratio test (lR test) statistical test was used for comparing the goodness of fit of Tobit model and Double-hurdle model in this study.

The test statistic for log-likelihood ratio at was 15 degrees of freedom (T= -186.2874) was statistically significant with Prob>chi2=0.0000 (See Annex C). But, the AIC criteria for the Tobit model is 406.5748 which is higher than that of Double-hurdle model which us 201.2679. So that, in this study Double hurdle model was preferred than Tobit model for estimation of determinants of wheat commercialization and its intensity.

Regarding Heckman two-step model, it was assumed that inverse mills ratio (IMR) must have to statistically significant. However in this study the probability of inverse mills ratio was 0.256 which is statistically insignificant which indicates no sample selection bias in the model (See Annex D). Thus, Heckman two-step model was not applied for this study. Therefore Double-hurdle model was employed.

Therefore, since the double hurdle model is the combination of probit and truncated regression model, the commercialization participation decision and its intensity (volume of wheat sale) were separately estimated and the model output estimated using 'Craggit' (See Annex E). The summation of Log pseudo-likelihood generated from the separate probit and truncated regression is equal to that generated by the Craggit command. This in turn it is possible whether the double hurdle model is estimated by the 'Craggit' command or separately using probit and truncated regression model (Engel & Moffatt, 2014).

The double hurdle model was used to identify factors affecting commercialization participation decision and intensity of market participation in wheat commercialization in the study area. The overall significance and goodness of fit of the model were checked with the value of Wald chi-square value of 97.74 at 15 degrees of freedom shows that the result is significant. The log pseudo-likelihood value of 133.63394 indicates that the assumption of a null hypothesis that all explanatory variables in the regression model are simultaneously equal to zero is rejected at less than 1% level of significance.

The Double-hurdle model result showed that out of 15 variable hypothesized to affect household decision to participate in wheat commercialization, ten (10) explanatory variables were found to significantly determine households' decision to participate in the wheat commercialization namely: family size, farm size allocated to wheat, access to market price information, distance to the nearest market, participation of off-farm income, access to credit service, family labor, total amount of wheat produced, preparation of feasting and membership of informal institutions.

**Family size of the household (Fmsize):** The Double-hurdle model of first hurdle result shows that family size of households was found significant and negatively related to the probability of commercialization in wheat output market at a 5% significance level. The marginal effect result show that as the member of household increased by one member, the probability of commercialized in wheat output commercialization decrease by 49%, keeping other factors being constant. The result is factual because household with more family member consume more output produced and supply small amount for market. This is in line with result of (Asmare & Beza, 2019; Dawana et al., 2018; Kassa, et al., 2017).

**Farm size allocated to wheat (Frmsize):** Land size allocated to wheat was positively and significantly affected the households' decision for wheat commercialization. The marginal effect shows that a one hectare increase in land allocated to wheat harvesting would increase the probability of wheat commercialization participation by 60%, keeping others factors being constant. This entails that a large land allocated to wheat helps to produce more output and it was an important factor for households to participate in market. This finding matches with the findings of (Ademe et al., 2017; Hassen et al., 2020; Leta, 2018).

Table 4.7 factors affecting commercialization participation decision of wheat output (probit model)

| **Commerc** | **Coeff.** | **Robust Std. Err.** | **Z** | **P>z** | **Marginal effect** |
|---|---|---|---|---|---|
| **Age** | .0097866 | .0132126 | 0.74 | 0.459 | 0.4672 |
| **Sex** | -.1477733 | .2748887 | -0.54 | 0.591 | 0.76667 |
| **Edn** | -.145312 | .1875452 | -0.77 | 0.438 | 0.5333 |
| **Fmsize** | -.2696764 | .1169059 | -2.31 | 0.021** | .491389 |
| **Frmsize** | 1.575761 | .8491917 | 1.86 | 0.064* | .602083 |
| **Freqext** | -.0284716 | .0303251 | -0.94 | 0.348 | 0.69722 |
| **Inf** | .6341726 | .3266502 | 1.94 | 0.052* | .908333 |
| **Dst** | -.1982547 | .0458719 | -4.32 | 0.000*** | .80708 |
| **Poffinc** | -.40194 | .2225007 | -1.81 | 0.071* | .466667 |
| **Crdt** | .9971367 | .3110437 | 3.21 | 0.001*** | .236111 |
| **Fmlbr** | .5444708 | .1692956 | 3.22 | 0.001*** | .22778 |
| **Amount** | .1509654 | .0497656 | 3.03 | 0.002*** | .22778 |
| **Cexp** | 0.0000029 | .0000591 | -0.04 | 0.966 | 0.6387 |
| **Feast** | -.6676287 | .2499357 | -2.67 | 0.008*** | .652778 |
| **Infins** | 1.480229 | .4112019 | 3.60 | 0.000*** | .933333 |
| **Cons** | -2.083849 | .8703307 | -2.39 | 0.017 | |
| **Log pseudo likelihood= -34.546041** | | | **Pseudo R2= 0.8212** | | |
| **Wald Ch2(15) = 75.70** | | | **Prob > chi2 = 0.0000** | | |

Commerc: refers decision to wheat commercialization participation
Source: Own survey, 2021

**Access to market price information (Inf):** The coefficient of dummy access to market price information "yes" of wheat producers was found to be positively and significantly influence the households probability of wheat commercialization. The marginal effect revealed that the access to market price information of households increases the households' probability of wheat commercialization by 90%, keeping other factors being constant. This could mainly be explained by the fact that those households who received market information from knew more about the price of wheat in order to sale their product. This findings are consistent with (Asmare & Muche, 2019; Mpombo, 2018).

**Distance from the nearest market (Dst):** Distance from the nearest market was negatively and significantly affects wheat commercialization decision of households'. The marginal effect shows that as the distance from households' resident to the nearest market increase by one kilometer, the probability of participation in the wheat commercialization decreased by 80% keeping other factors being constant. Thus, households far away from market places have lower market participation because of its transaction costs. This result was supported by (Endalew et al., 2020; Tadele et al., 2017).

**Participation off-farm income (Poffinc):** the coefficient of dummy participation in off-farm income "yes" of wheat producers was found to be positively and significantly affects the households' probability of participation in wheat commercialization. The marginal effect shows that participation in off-farm income generating activities decreases the households' probability of wheat commercialization by 46%, keeping other factors being constant. This implies that participating in off-farm activities like fire wood selling, petty trade, house rent and daily work discourages participation in wheat commercialization. The result is in line with the previous empirical studies (Asmare & Muche, 2019; Bekele, A., 2017).

**Access to credit service (Crdt):** The coefficient of dummy access to credit service "yes" of wheat producers was found to have positive and significant effect on participation decision of wheat commercialization. The marginal effect show that as the credit use of households increase the probability of participation in wheat output market increase by 23%, keeping other factors being constant. This implies that credit using enables households to utilize available technology that used for wheat harvesting, improved seed and fertilizer. The results was supported by the results of (Endalew et al., 2020; Mutabazi et al., 2013).

**Family labor (fmlbr):** Family labor amount participated in wheat harvesting activity per day was found to be positively and significantly influence participation decision of wheat commercialization. The marginal effect revealed that as the number of labor participated in wheat production increases by one, the probability of households participated for wheat commercialization increases by 22%, keeping other factors being constant. This implies that a household with large working labor force will be in a position to achieve the labor intensive wheat harvesting activities. This finding is in line with the finding of (Asmare & Muche, 2019; Dawana et al., 2018; Gedefaw, 2019)

**Total amount of wheat produced (amount):** Total quantity of wheat produced by households was found to have positive and significant influence on wheat commercialization participation. The marginal effect show that a one quintal increase in wheat production, leads to increase in probability of wheat commercialization by 22%, keeping other factors being constant. This entails that households which produces larger amount of wheat simply cover its consumption and commercialize the rest. Hence, increasing wheat products play a significant role in wheat commercialization; generating and distributing improved wheat technologies would bring a positive effect in wheat sector both for production and marketing (Tadele et al., 2017). The findings of (Abera, 2009) supports this findings.

**Preparation of feasting (Feast):** The coefficients of dummy preparation of feasting "yes" of wheat producer households was found to be negatively and significantly affects participation in wheat commercialization. The marginal effect show that as a preparation of feasting of households increases, a probability of wheat commercialization by households decreases by 65%, keeping other factors constant. This means farmers are spending proportion of their wheat production for feasting that would otherwise sold. Values, norms, sanctions, taboos, cultures, traditions etc. have strong influences on smallholder production and marketing decisions (Jaleta, 2010).

**Membership of informal institutions (Infins):** The coefficients of dummy of membership of informal institutions "yes" of households was found to have positive and significant influence on participation of wheat commercialization. The marginal effect show that as a membership of informal institution of households increases, a probability of wheat commercialization by households decreases by 93%, keeping other factors constant.

As of formal institutions, informal institution has strong influences on smallholder production and marketing decisions (Lampé, 2006). Moreover, rural institutions are an opportunity for crop commercialization as these institutions are sources of finance and information on transaction of agricultural produces (Hailua et al., 2015).

### 4.2.3 Determinants of the Intensity of Wheat Commercialization

The second hurdle result which is the intensity or extent of participation of the households in wheat output commercialization as a fraction of total wheat produced was presented in the table 4.8 The result showed that out of 15 explanatory variables included in the model five (5) of them were found to be significant, namely; access to market price information, total amount of wheat produced, cash expenditure for input, preparation of feasting and membership of informal institutions.

**Access to market price information (Inf):** Access to market price information had positive influence on intensity of wheat commercialization at 5% level of significance. This implies that if access to market price information increases by one unit, the intensity of wheat commercialization increased by 7.09%, keeping other factors constant. The information was captured from neighbors, friends, traders and market participant farmers. The result was in line with the result of (Martey, 2014; Gedefaw, 2019; Sultan, 2016b).

**Total amount of wheat produced (amount):** The regression coefficient of total wheat production of the household was found to have a positive and significant influence on marketed surplus at a 1% significance level. As the result indicated that as the total product of wheat increase by one quintal, the amount of wheat supplied to market would be increase by 2.64%, keeping other factors constant. This could be explained by the fact that higher wheat harvests result into surpluses that translates into higher sales. This result was consistent with the results of (Hassen et al., 2020; Mpombo, 2018).

Table 4.8 factors affecting volume of wheat sale (second hurdle/truncated regression)

| HCI | Coeff. | Robust Std. Err. | Z | P>z |
|---|---|---|---|---|
| **Age** | .0007786 | .0008089 | 0.96 | 0.336 |
| **Sex** | -.0063832 | .0168548 | -0.38 | 0.705 |
| **Edn** | -.0151637 | .0111372 | -1.36 | 0.173 |
| **Fmsize** | -.007892 | .0088301 | -0.89 | 0.371 |
| **Frmsize** | -.0397889 | .0463787 | -0.86 | 0.391 |
| **Freqext** | .001737 | .0012417 | 1.40 | 0.162 |
| **Inf** | .0709703 | .0308273 | 2.30 | 0.021** |
| **Dst** | .0009948 | .0035888 | 0.28 | 0.782 |
| **Poffinc** | .0065459 | .0136163 | 0.48 | 0.631 |
| **Crdt** | -.0061825 | .0145619 | -0.42 | 0.671 |
| **Fmlbr** | -.0148168 | .0097722 | -1.52 | 0.129 |
| **Amount** | .0264218 | .0023317 | 11.33 | 0.000*** |
| **Cexp** | 0.000000775 | 0.00000027 | 2.87 | 0.004*** |
| **Feast** | -.0370981 | .0143154 | -2.59 | 0.010*** |
| **Infins** | .105623 | .040197 | 2.63 | 0.009*** |
| **_Cons** | .0561127 | .0680452 | 0.82 | 0.410 |
| **/Sigma** | .1066841 | .0044075 | 24.20 | 0.000 |
| **Number of observations = 275** | | | **Log likelihood = 99.087899** | |
| **Wald chi2 (15) = 636.25** | | | **Prob>Chi2 = 0.0000** | |

HCI = refers household commercialization index

Source: Own survey, 2021

**Cash expenditure for input utilization (Cexp):** Total cash expenditure spent for wheat harvesting and marketing was found to have positive and significant effect on intensity of wheat commercialization at 1% significant level. This implies that as cash expenditure spent on wheat increases by one birr (ETB), the intensity of wheat commercialization would be increases by 0.00075%, keeping other factors constant.

This includes expenditure spent for utilization of improved seed, fertilizer, labor, storage and transportation cost. Therefore, utilizing appropriate inputs that used for wheat production encourages intensity of commercialization via increasing production capacity. The result was in line with the findings of (Girma, A., 2017).

**Preparation of feasting (feast):** Preparation of feasting had negative influence on intensity of wheat commercialization at 1% level of significance. This implies that if preparation of feasting increases by one unit, the intensity of wheat commercialization increased by 37%, keeping other factors constant. This includes feasting of weeding, birthday, graduation, mahber/sanbate and teskar. This entails that preparation of feasting decreases the volume of wheat supplied to market.

**Membership of informal institutions (Infins):** Membership of informal institutions had positive influence on the volume of wheat supplied to market at 1% level of significance. The truncated regression model result revealed that if membership of informal institutions increases by one unit, the intensity of wheat commercialization increased 10%, keeping other factors constant. This implies that members of iddir, sharecropping and equb supplies more wheat to market. The result supported by the study of (Hagos, A. and Geta, E., 2017)

### 4.2.4 Income effects of Wheat Commercialization

The wheat commercialization impacts on households income was presented in this subsection. It was estimated by using propensity score matching model. Propensity score matching model was used for this study because it uses for effect analysis, reduce bias due to lack of distribution overlap and bias due to different density weighting. Moreover, propensity score matching model used for estimation of average treatment effects (Diop et al., 2011).

The propensity score is defined as the probability that a unit in the combined sample of treated and untreated units receives the treatment, given a set of observed variables. If all information relevant to participation and outcomes is observable to the researcher, the propensity score (or probability of participation) will produce valid matches for estimating the impact of an intervention. Therefore, rather than attempting to match on all values of the variables, cases can be compared on the basis of propensity scores alone (Heinrich & Heinrich, 2010). Therefore, in this study it estimates the gain from wheat commercialization.

The necessary steps to implement propensity score matching are: Propensity Score estimation, Choose matching algorithm, common support, estimate ATT and finally check sensitivity.

Before estimating propensity score the appropriate model was developed. So that, if a given propensity score equation comes up with significant and expected signs to key variables, and has a better accuracy, measured by relatively higher pseudo-R2, that model can be considered as preferred specification. To estimate the propensity score matching the appropriate econometric models were logit and probit model. Since the outcome of both models is the same, Logit model was used in this study to estimate propensity score matching for commercialized and non-commercialized group of households. Then, to estimate the effect of treatment on households' income, PSM with different matching algorithms: nearest neighbor matching **(**NNM), caliper matching and kernel matching **(**KM) were most importantly used (Caliendo et al., 2005).

Matching of the treated and control households were mostly employed to estimate the common support region. The main criterion for estimating the common support region is to delete observations whose PSM is lower than the minimum PSM of treated (commercialize) and higher than the maximum in the control (not commercialize) households. This reduces selection bias when participation in commercialization determined by observable (Li, 2012).

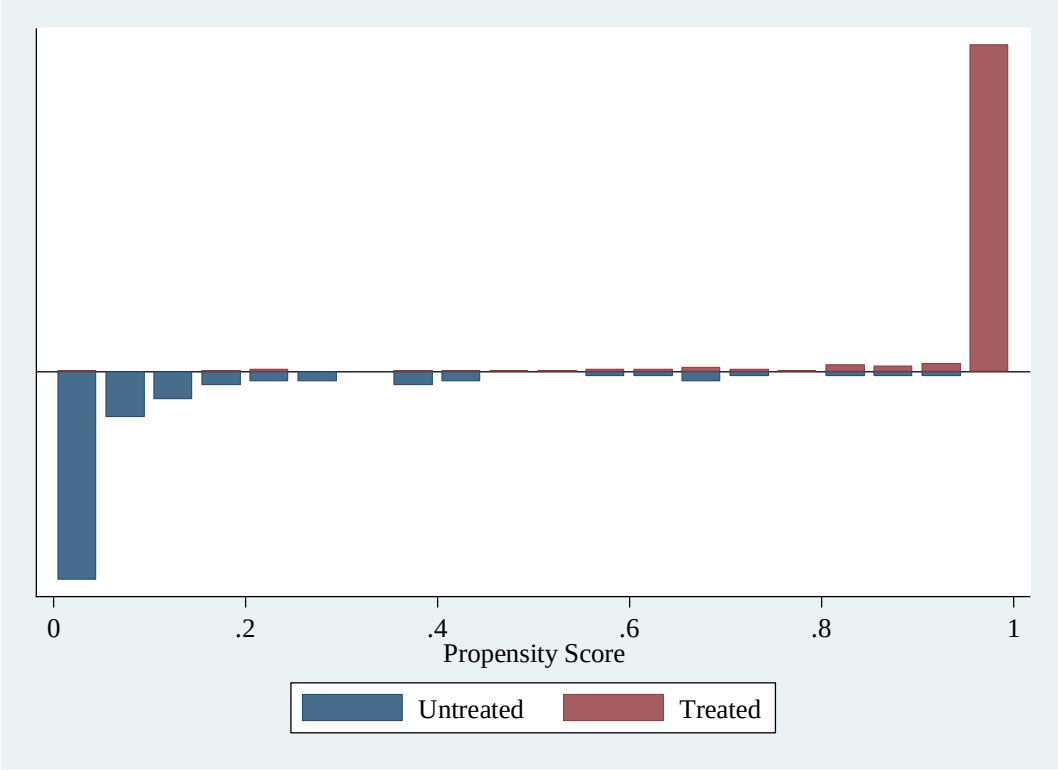
The summary of statistics was indicated on the table 4.9 below. According to the evidence from the below table the common support region ranges between propensity score of 0.009 and 0.9. This is the region between the minimum propensity score of the treated and the maximum propensity score of control farmers in wheat commercialization. Thus, the welfare impact analysis considered the observations lied in common support region.

Table 4.9 determination of common support region

| **Observations** | **mean** | **Std. dv** | **Min** | **Max** |
|---|---|---|---|---|
| **Commercialized (278)** | .9593357 | .13492 | .0090948 | 1 |
| **Not-commercialized(82)** | .137862 | .2277349 | 0.00000368 | .9067575 |
| **Total(360)** | .7722222 | .3804934 | 0.000000368 | 1 |

Source: Own survey, 2021

Figure 4.6 Propensity score distribution before matching




Source: Own survey, 2021

Next, the matching algorithm should be identified in order to reduce selection bias. Nearest neighbor matching (NNM), caliper matching and kernel matching (KM) are the most commonly used matching estimators. All matching estimators contrast the outcome of a treated individual with outcomes of comparison group members (Caliendo et al., 2005).

The final choice of a matching estimator can be done taking selecting criterion like balancing test, pseudo-R2 and matched sample size. A matching estimator which balances all explanatory variables (i.e., results in insignificant mean differences between the two groups), a model which bears a low pseudo R2 value and results in large matched sample size is a preferable matching algorism (Becker & Ichino, 2002).

Table 4.10 Matching algorithm competition results

| Matching algorithm | Balancing property | Pseudo R2 after matching | LR Chi2 of logit model after matching | | No. of matched sample size |
|---|---|---|---|---|---|
| | | | LR Chi2 | Prob. | |
| **Kernel Matching** | | | | | |
| **Bandwidth=0.08** | 15 | 0.104 | 6.60 | 0.980 | 105 |
| **Bandwidth=0.10** | 15 | 0.079 | 5.02 | 0.996 | 105 |
| **Bandwidth=0.25** | 15 | 0.061 | 3.88 | 0.999 | 105 |
| **Bandwidth=0.30** | 15 | **0.057** | **3.62** | **0.999** | **105** |
| **Bandwidth=0.50** | 15 | 0.062 | 3.94 | 0.999 | 105 |
| **Nearest Neighbor Matching (NNM)** | | | | | |
| **Neighbor one** | 14 | 0.206 | 13.14 | 0.663 | 105 |
| **Neighbor three** | 15 | 0.106 | 6.77 | 0.977 | 105 |
| **Neighbor five** | 15 | 0.077 | 4.92 | 0.996 | 105 |
| **Caliper Matching** | | | | | |
| **Caliper=0.01** | 15 | 0.100 | 20.19 | 0.875 | 91 |
| **Caliper=0.05** | 14 | 0.271 | 13.52 | 0.635 | 100 |
| **Caliper=0.1** | 15 | 0.206 | 13.14 | 0.663 | 105 |

Source: Own survey, 2021

The matching result of the algorithms presented on the table 4.10 above. Therefore as the evidence from the above graph indicates that kernel matching estimators with 0.3 bandwidth was selected because, it satisfies the criteria of choosing better than other matching estimators. As indicated on the table relatively this algorithm resulted in least pseudo R2 (0.057), high balancing test after matching for all variables, matches large sample size (105) and insignificant LR Chi2.

After choosing the matching algorithm, the next activity is to check the balancing of propensity score and covariates using various techniques by the chosen matching estimator. The primary purpose of the propensity score estimation is not to obtain a precise prediction of selection into treatment, but rather to balance the distributions of covariates in both groups.

Table 4:11 Propensity score and covariate balance test

| Variable | Unmatched / Matched | Mean | | Standard bias % | Reduction bias % | t-test | p>\|t\| |
|---|---|---|---|---|---|---|---|
| | | treated | Control | | | | |
| **Age** | Unmatched | 44.831 | 44.134 | 7.0 | | 0.55 | 0.582 |
| | Matched | 41.696 | 41.87 | -1.7 | 75.0 | -0.07 | 0.945 |
| **Sex** | Unmatched | .76978 | .7561 | 3.2 | | 0.26 | 0.797 |
| | Matched | .82609 | .84497 | -4.4 | -38.0 | -0.17 | 0.867 |
| **Edn** | Unmatched | 1.5 | 1.6463 | -23.5 | | -1.93 | 0.054** |
| | Matched | 1.5217 | 1.4188 | 16.6 | 29.6 | 0.63 | 0.535 |
| **Fmsize** | Unmatched | 4.9029 | 4.9512 | -3.4 | | -0.28 | 0.779 |
| | Matched | 4.5652 | 4.4297 | 9.6 | -180.3 | 0.30 | 0.765 |
| **Frmsize** | Unmatched | .69063 | .30189 | 178.2 | | 12.17 | 0.000*** |
| | Matched | .36413 | .37101 | -3.2 | 98.2 | -0.18 | 0.858 |
| **Dst** | Unmatched | 4.5444 | 5.6976 | -43.7 | | -3.95 | 0.000*** |
| | Matched | 4.6522 | 5.456 | -10.5 | 30.3 | -0.79 | 0.436 |
| **Poffinc** | Unmatched | .45683 | 0.5 | -8.6 | | -0.69 | 0.492 |
| | Matched | .34783 | .36169 | -2.8 | 67.9 | -0.10 | 0.924 |
| **Amount** | Unmatched | 12.585 | 4.5854 | 199.1 | | 12.96 | 0.000*** |
| | Matched | 5.3043 | 5.6329 | -8.2 | 95.9 | -0.71 | 0.483 |
| **Cexp** | Unmatched | 6829.7 | 4887.7 | 82.1 | | 5.66 | 0.000*** |
| | Matched | 5469 | 5496.6 | -1.2 | 98.6 | -0.05 | 0.962 |
| **Feast** | Unmatched | .6223 | .7561 | -29.1 | | -2.25 | 0.025** |
| | Matched | .52174 | .41073 | 14.1 | 17.0 | 0.74 | 0.462 |
| **Infins** | Unmatched | .98561 | .7561 | 72.4 | | 7.91 | 0.000*** |
| | Matched | .52174 | .87541 | 15.6 | 64.7 | 0.98 | 0.332 |
| **Freqext** | Unmatched | 9.6835 | .96341 | 152.5 | | 9.98 | 0.000*** |
| | Matched | 1.6522 | 1.9043 | -4.4 | 97.1 | -0.28 | 0.778 |
| **Inf** | Unmatched | .94604 | .78049 | 49.4 | | 4.69 | 0.000*** |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Matched | .78261 | .78851 | -1.8 | 96.4 | -0.05 | 0.962 |
| **Crdt** | Unmatched | .28058 | .08537 | 52.0 | | 3.72 | 0.000*** |
| | Matched | .21739 | .10891 | 18.9 | 44.4 | 0.98 | 0.330 |
| **Fmlbr** | Unmatched | 3.3381 | 2.8537 | 49.7 | | 3.76 | 0.000*** |
| | Matched | 2.9565 | 2.9533 | 0.3 | 99.3 | 0.01 | 0.991 |

***, and ** show significance at 1% and 5% probability level respectively

Source: Own survey, 2021

The balancing powers of the estimations are ensured using different test methods such as the reduction in the mean standardized bias between the matched and unmatched households, equality of means using t-test (Caliendo et al., 2005). The mean standard bias before and after matching conducted was shown on the Table 4.11 above. The standardized bias difference in covariates before matching was lie between 3.2% and 152.5% in absolute value. However, after matching the standardized bias difference for all covariates was lie between 0.3 % and 18.9 % in absolute value, which is less than the critical level of 20% as explained by (Abadie et al., 2004). Similarly, t-values in the table show that before matching eleven variables found to be statistically significant differences while after matching all of the covariates are balanced.

The low pseudo R2 and the insignificant likelihood ratio tests support the hypothesis that both groups have the similar distribution in observable characteristics after matching (see Table 4.12). Therefore, the criteria was used to estimate the effect of wheat commercialization participation on rural household's income for those having similar observed characteristics. This was used to compare observed outcomes for treated with those of a control groups found in a common support region.

Table 4.12 Chi2 test for the joint significance of variables

| Sample | Pseudo R2 | LR chi2 | p>chi2 |
|---|---|---|---|
| **Unmatched** | 0.822 | 317.70 | 0.000 |
| **Matched** | 0.057 | 3.62 | 0.999 |

Source: own survey, 2021

Then, the ATT was computed by using kernel matching estimator 0.3 bandwidth. The income effect of wheat commercialization was represented by total annual income of the households. The results of ATT was presented on the table 4.13.

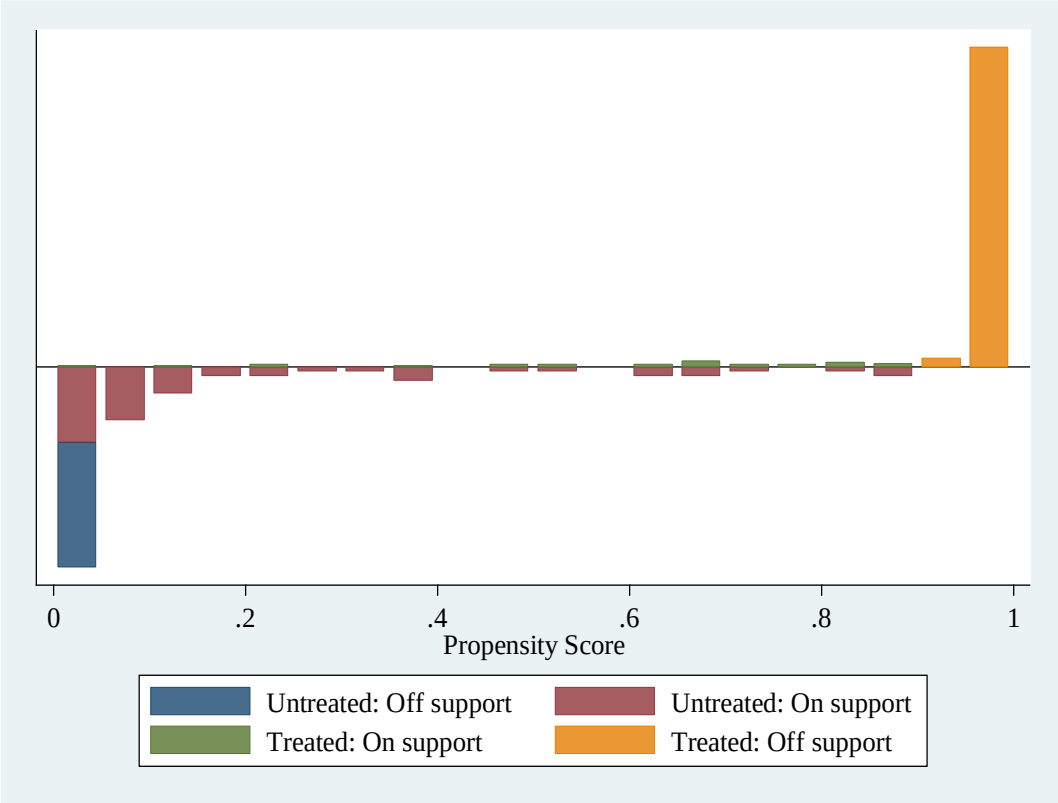
Table 4.13 Average treatment effect from PSM model (Kernel matching estimator)

| Outcome | Sample | Treated | Control | Difference | T-stat |
|---|---|---|---|---|---|
| **Income** | ATT | 20634.7826 | 18986.9044 | 1647.87819 | 0.68 |

Source: Own survey, 2021

The effect of wheat commercialization on household's income was based on a sample of matched treated and control groups, the estimated average treatment effect (ATT) significant effect on the income of households. The average income of commercialize households was higher by 1647.88 ETB in a given year than non-commercialized households'. The result was in line with (Abera, 2009; Osmani et al., 2014). Therefore, these findings indicate that commercializing smallholder agriculture is an essential path towards improving income of households and economic growth for developing countries that rely on agricultural production.

Figure 4.7 Propensity score distribution after matching




Source: Own survey, 2021

#### 4.2.4.1 Sensitivity analysis for average treatment effect on treated

In some cases, the conditional independence assumption is clearly not met because units are selected into an intervention on the basis of unmeasured characteristics that are expected to influence outcomes (Heinrich & Heinrich, 2010). The approach allows determining how much hidden bias would need to be present to render plausible the null hypothesis of no effect or in another words how strongly an unmeasured variable must affect the selection process in order to undermine the implications of matching analysis(Li, 2012).

Therefore, sensitivity analysis is the final diagnostic that must be performed to check the sensitivity of the estimated treatment effect to small changes in the specification of the propensity score due to unobserved factors. The sensitivity test employed for this study indicates that the ATT difference in welfare of treated and control groups was free from the effect of unobserved factors (see annex J).

# CHAPTER FIVE

# CONCLUSION AND RECOMMENDATIONS

This section presents the last part of the paper which incorporates the conclusion and recommendations of the study.

## 5.1Conclusion

In this paper, determinants of wheat commercialization and its effects on incomes of smallholder households was examined by using a primary data collected from 360 sample households in four sub districts of Basona Werana district. The area was chosen due to low market participation of wheat, in spite of its potential wheat growing area. The descriptive and Double-hurdle inferential analysis was employed to identify factors responsible for their low market participation. Further propensity score matching model was employed to distinguish income effects of wheat commercialization.

Out of total sampled households' 77.22% of households participates for wheat commercialization while the rest 22.78% of the respondents didn't supply their wheat product to the market. According to the results of of household wheat commercialization index (HCI), more than half of the smallholder farmers are semi-commercialized (54.4%), while 37.78% of them are fully subsistence and only 7.78% of the smallholder farmers are fully commercialized.

The results of double hurdle regression model have also indicated policy relevant variables that have greatest influence on wheat commercialization participation and intensity of wheat commercialization of smallholder farmers. As the result of first hurdle (probit) model indicated that out of fifteen explanatory variables ten (10) variables was found to have significant effect on probability of wheat commercialization. Among significant explanatory variables farm size allocated to wheat, access to market price information, access to credit service, family labor, total amount of wheat produced and membership of informal institutions positively and significantly influence wheat commercialization participation decision while size of family member, participation of off-farm income, distance from the market and preparation of feasting has inverse significant effect on wheat commercialization decision of households.

The result of second hurdle model using truncated regression model revealed five (5) explanatory variables were significant. Access to market price information, total amount of wheat produced, cash expenditure for input utilization and membership of informal institutions was found to have positive and significant effect on intensity of wheat commercialization while preparation of feasting have negative and significant effect on it.

Finally, propensity score matching model (PSM) was used to compare the income of wheat commercialization participant and non-participant households. Among nearest neighbor, caliper and kernel matching algorithms, kernel bandwidth 0.3 matching algorithm satisfies the criteria of balancing test, low pseudo R2 and large sample size. Therefore, the propensity score matching model result show that, there is statistically significant difference in income between control and treated group.

## 5.2 Recommendations

The findings discussed above provides the following recommendations:

- The researcher recommend that, government and other responsible body should have to give priority for wheat commercialization by investing in necessary and transaction cost reduction activities like emerging nearest market/village.
- The study found that credit using was found to have positive effect on wheat commercialization participation but only about 23.61% of the respondents are beneficiary. So that microfinance institutions, saving and credit associations and banks should have to increase credit services for smallholder farmers.
- Since about 93.33% of the respondents are members in informal institutions' and the institutions positively affects wheat commercialization, empowering informal institutions and creating awareness for smallholder farmers to reduce unnecessary extravagancies by reducing feasting also important to improve smallholder farmers' welfare through commercialization.
- In this study wheat commercialization was found to positively affect income of households. Therefore, farmers should specialize in wheat production and marketing to enjoy better living standards. Researchers, government, NGOs and other responsible bodies should give priority to reduce factors that hinder smallholder farmers from producing and marketing wheat.

## 5.3 Limitations and suggestions for future studies

The study only covered wheat production and marketing for the year 2020 and its welfare impacts, further studies could aim to look at how smallholder farmers carry out in the marketing of other crops. This study is focused only on wheat commercialization using cross sectional data (1 year). Further studies should also focus on agricultural commercialization using panel data.

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# APPENDICES

## Annex A: Household Survey Questionnaire

Determinants of Commercialization of Wheat and its income effects on Smallholder Farmers of Basona Werana Districts

**Purpose:** This questionnaire is prepared with the aim of collecting data relating to wheat commercialization of smallholder farmers and its effects on incomes of smallholder farmers. This questionnaire will serve as a major input for the master thesis research being conducted in pursuit of purely academic purpose and will not be disclosed to any third party. Hence, the respondent is kindly requested to provide us his/her genuine responses to the sets of questions included herewith in the questionnaire. We would like to firmly assure the respondent on the confidentiality of the responses. Thank you in advance for your cooperation!!!

**Name of Interviewer: _____**

**Date of interview: _____**

**Kebelle: _____**

**Contact address:** 0921487214/0909411466

**A. Demographic characteristics of households**

1. Age of household head in years _____
2. Sex of household head 1. Male 2. Female
3. Educational status of household head 1. Unable to read and write (illiterate) 2. Primary school 3. Secondary school 4. Above secondary
4. Total family size including you _____

**B. Land use information**

5. Total land holding_____ hectares
6. Cultivated area _____ hectares
7. Cultivated area for wheat production _____ hectares in meher season of 2020 production period

**C. Access to extension service**

8. Did you get extension service in relation to wheat production in 2020? 1. Yes 2. No

9. If yes, who provides the extension service? 1. DA's 2. Office of agriculture 3. NGO's 4. Model farmers 5. Others (specify) _____
10. What types of extension service did you get? 1. Input use 2. Crop management 3. Product marketing 4. Credit use 5. Others_____
11. If you had an extension contact in 2020 production year, how frequent did you meet with them especially for wheat production? (number of days)_____
12. If your answer for question No. 8 is 'No' what are the reasons not to get it?_____

**D. Access to market information**

13. Did you know market price before you sold your wheat? 1. Yes 2. No
14. If yes, what was/were your source of wheat market information (multiple answers possible)? 1. Traders 2.Mass media (Newspaper, TV, Radio) 3.Cooperatives 4.union 5. DA's 6.Market participant farmers 7. Friends/neighbors 8. Others (specify) _____

**E. Distance from the market**

15. What is the nearest output market where you mainly sale your wheat products? _____
16. How far it is from your residence? _____ Kilometers
17. Do you have modern transport access to the nearest market? 1. Yes 2. No

**F. Off-farm income**

18. Do you /your family participate in off/non-farm activities? 1. Yes 2. No
19. If yes, fill the next table for 2020 production year

| Income source | Responsible family members | | | Estimated income |
|---|---|---|---|---|
| | Men | Women | Children | |
| Petty trade (grain, vegetable, livestock, fruits, etc.) | | | | |
| Daily labor | | | | |
| Remittance | | | | |
| Handcraft | | | | |
| House rent | | | | |
| Fire wood sale | | | | |
| Others (specify) | | | | |
| **Total** | | | | |

**G. Access to credit**

20. Did you borrow money for wheat production in 2020? 1. Yes 2. No
21. If yes, how much it was?_____ Birr
22. If your answer for #24 is yes, for what purpose you used? 1. For purchase of fertilizer and seed 2. For payment of hired labor 3. Purchase of farm implements 4. Purchase of oxen 5. Others (specify)_____
23. From where did you get the credit service? 1. Cooperative 2. Micro finance 3. NGOs 4. Informal money Lender 5. Saving and credit Association 6. Others(specify)_____
24. If answer for #24 is No, why? 1. No need 2. High interest rate 3. Lack of collateral 4. Fear of inability to repay 5. No service 6. Others(specify)_____
25. What was the precondition to get credit? 1. Membership 2. Personal guarantee 3. Land holding 4. Collateral 5. Others (specify)_____
26. Do you have any problems in getting credit? 1. Yes 2. No
27. If yes, what is the nature of your credit problem(s)? 1. Few supply 2. Absence of informal sources 3. Unfavorable repayment time 4. High interest rates 5. Restrictive procedures 8. Others (Specify)_____

**H. Family Labor**

28. How much is your family labor participating in wheat production? _____
29. What did the labor composition of your farm look like in the last wheat production year?

| Activities | Family labor | | | Hiring | |
|---|---|---|---|---|---|
| | Men >17 | Women >17 | Children | Quantity | Wage/Day |
| Plowing (land preparation) | | | | | |
| Sowing | | | | | |
| Weeding | | | | | |
| Chemical application | | | | | |
| Harvesting | | | | | |
| **Total** | | | | | |

**I. Wheat Production and marketing**

30. Why do you engage in wheat production? 1. High demand 2. Disease resistance 3.Resource suitability 4. High price 5. Other reasons (specify) _____

31. How long have you been in wheat production? _____ years

32. How much wheat you produce in 2020_____ in quintals?

33. Have you sold wheat in 2020? 1. Yes 2. No

34. If answer No #33 is yes, how much wheat you sold in 2020 _____ in quintals?

35. What was the trend of wheat price from 2018-2020? 1. Increase 2. Decrease 3. Constant

36. What was your selling capacity of wheat from 2018-2020? 1. Increase 2.Decrease 3.As it is (constant).

**J. Cash expenditure for wheat production**

37. Have you used agricultural inputs (fertilizer, chemical, improved seeds, etc.) for the production of wheat? 1. Yes 2. No

| Type of input | | Did you use for wheat 1. Yes 2. No | Price per (Qty/ltr) | Amount used per hectare | Source(*) |
|---|---|---|---|---|---|
| Improved seed | | | | | |
| Fertilizer | UREA | | | | |
| | DAP | | | | |
| Herbicide | | | | | |
| Fungicide | | | | | |
| Insecticide | | | | | |
| Others (specify) | | | | | |

*1. Own 2. Government 3.Cooperative/union 4. Private traders

38. If answer #40 is no, why? 1. High price 2. Limited supply 3.Lack of credit access 4.Quality problem 5. Others (specify)

39. What is the input price trend from 2018-2020? 1. Increase 2. Decrease 3. Constant

**k. Feasting**

40. Did you prepared feast in 2020? 1. Yes 2. No

41. If yes, what was the program? /multiple answers possible 1. Weeding 2.Sanbate 3.Mahber 4.Birthday 5.Teskar 6.Graduation 7. Other _____

42. How much wheat did you spent for the feast _____ quintal?

**L. Membership of informal institutions**

43. Are you a member in an informal institution whether it is social/religious?/ multiple answers possible 1. Yes 2. No

44. If yes, what was it? /multiple answers possible 1. Idir 2.Equb 3. Share cropping 4. Other _____

45. If answer #46 is yes, what benefit did you get? /multiple answers possible 1. Support during death 2. Support during sickness 3. Borrow money for input purchasing 4. Saving money 5. Experience share 6. Other _____

**M. Household welfare indicators**

46. How much income did you earn in 2020 _____ Birr?

47. Non-food expenditure/ consumption of households in the last 12 months

| No. | Type of non-food consumed/purchased | Total expenditures in Birr |
|---|---|---|
| 1 | Education and health per year | |
| 2 | Clothes and shoes per year | |
| 3 | Durables (radio, bed, mattress, mobile, farm implements, etc.) (total in the last production year) | |

# Annex B: Diagnostic taste result

## Multicollinearity test

```
. vif
```

| Variable | VIF | 1/VIF |
|---|---|---|
| amount | 5.25 | 0.190327 |
| logfrmsize | 4.07 | 0.245445 |
| freqext | 2.96 | 0.337403 |
| fmsize | 2.42 | 0.413008 |
| fmlbr | 2.17 | 0.461833 |
| age | 1.55 | 0.644831 |
| logcexp | 1.54 | 0.648371 |
| dst | 1.16 | 0.861284 |
| sex | 1.13 | 0.888178 |
| inf | 1.13 | 0.888697 |
| edn | 1.11 | 0.897522 |
| infins | 1.09 | 0.918536 |
| crdt | 1.07 | 0.937734 |
| feast | 1.06 | 0.943458 |
| poffinc | 1.05 | 0.956585 |
| Mean VIF | 1.92 | |

## Hetroschedasitcity test

```
. hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of commerc

         chi2(1)      =    29.62
         Prob > chi2  =   0.0000
```

## Annex C: Tobit model estimation result

```
. tobit commerc age sex edn fmsize frmsize freqext inf dst poffinc crdt fmlbr amount cexp feast infins, ll

Tobit regression                                Number of obs     =        360
                                                LR chi2(15)       =     263.10
                                                Prob > chi2       =     0.0000
Log likelihood =  -186.2874                     Pseudo R2         =     0.4139

------------------------------------------------------------------------------
     commerc |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         age |   .0022519   .0024492     0.92   0.359    -.0025653    .0070692
         sex |   .0147485     .04992     0.30   0.768    -.0834373    .1129343
         edn |  -.0598237   .0350664    -1.71   0.089    -.1287947    .0091472
      fmsize |  -.0595591   .0231024    -2.58   0.010    -.1049984   -.0141199
     frmsize |   .2261561   .1441181     1.57   0.118    -.0573047    .5096168
     freqext |  -.0034023   .0042706    -0.80   0.426     -.011802    .0049974
         inf |    .217681   .0777915     2.80   0.005     .0646757    .3706863
         dst |  -.0451691   .0093203    -4.85   0.000    -.0635009   -.0268374
     poffinc |  -.0994423   .0408356    -2.44   0.015    -.1797603   -.0191242
        crdt |   .1755175   .0468941     3.74   0.000     .0832833    .2677517
       fmlbr |   .0553362   .0280877     1.97   0.050     .0000916    .1105809
      amount |   .0375829   .0077916     4.82   0.000     .0222579    .0529079
        cexp |  -.0000183   8.62e-06    -2.12   0.035    -.0000352   -1.31e-06
       feast |  -.1008763   .0433686    -2.33   0.021    -.1861765   -.0155762
      infins |   .7718352   .1087326     7.10   0.000      .557973    .9856974
       _cons |  -.2214023   .1876803    -1.18   0.239     -.590544    .1477394
-------------+----------------------------------------------------------------
       /sigma |    .363646   .0164863                      .3312196    .3960723
------------------------------------------------------------------------------
          82  left-censored observations at commerc <= 0
         278     uncensored observations
           0 right-censored observations
```

## Annex D: Heckman Two-Step Selection model Estimation

```
. heckman commerc age sex edn fmsize frmsize freqext inf dst poffinc crdt fmlbr amount cexp feast infins, select(HCI=age sex edn fmsize frmsize freqext inf dst poffinc crdt fmlbr amount ce
> xp feast infins)
```

Heckman selection model -- two-step estimates
(regression model with sample selection)

| | |
|---|---|
| Number of obs | 360 |
| Censored obs | 82 |
| Uncensored obs | 278 |
| Wald chi2(15) | 262.30 |
| Prob > chi2 | 0.0000 |

| | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| HCI | | | | | | |
| age | .0007868 | .0010158 | 0.77 | 0.439 | -.0012042 | .0027778 |
| sex | -.0289103 | .0209817 | -1.38 | 0.168 | -.0700337 | .0122132 |
| edn | -.0033691 | .0149886 | -0.22 | 0.822 | -.0327462 | .026008 |
| fmsize | -.0095283 | .0101741 | -0.94 | 0.349 | -.0294692 | .0104125 |
| frmsize | -.0165819 | .060771 | -0.27 | 0.785 | -.1356908 | .1025271 |
| freqext | .0014112 | .0016645 | 0.85 | 0.397 | -.0018511 | .0046736 |
| inf | .0947922 | .038759 | 2.45 | 0.014 | .018826 | .1707584 |
| dst | -.0039992 | .0044852 | -0.89 | 0.373 | -.0127901 | .0047916 |
| poffinc | .0057042 | .0173276 | 0.33 | 0.742 | -.0282572 | .0396657 |
| crdt | .0043808 | .0193206 | 0.23 | 0.821 | -.033487 | .0422485 |
| fmlbr | .0001904 | .0119253 | 0.02 | 0.987 | -.0231827 | .0235636 |
| amount | .0210188 | .0033393 | 6.29 | 0.000 | .0144739 | .0275636 |
| cexp | 9.06e-06 | 3.48e-06 | 2.61 | 0.009 | 2.25e-06 | .0000159 |
| feast | -.062667 | .0181777 | -3.45 | 0.001 | -.0982947 | -.0270393 |
| infins | .0660962 | .075431 | 0.88 | 0.381 | -.0817458 | .2139382 |
| _cons | .1022645 | .1075478 | 0.95 | 0.342 | -.1085253 | .3130542 |
| commerc | | | | | | |
| age | .0326409 | .025751 | 1.27 | 0.205 | -.0178301 | .0831119 |
| sex | -.1155753 | .4740759 | -0.24 | 0.807 | -1.044747 | .8135964 |
| edn | .0276766 | .3614547 | 0.08 | 0.939 | -.6807616 | .7361147 |
| fmsize | -.4193831 | .204445 | -2.05 | 0.040 | -.8200878 | -.0186783 |
| frmsize | 3.842705 | 1.621756 | 2.37 | 0.018 | .664121 | 7.021289 |
| freqext | -.0624501 | .0828089 | -0.75 | 0.451 | -.2247526 | .0998524 |
| inf | .5525371 | .4898361 | 1.13 | 0.259 | -.4075239 | 1.512598 |
| dst | -.3389302 | .085203 | -3.98 | 0.000 | -.5059251 | -.1719353 |
| poffinc | -.9194777 | .438645 | -2.10 | 0.036 | -1.779206 | -.0597492 |
| crdt | .6058208 | .5142104 | 1.18 | 0.239 | -.402013 | 1.613655 |
| fmlbr | .3908517 | .2940291 | 1.33 | 0.184 | -.1854348 | .9671383 |
| amount | .850783 | .1788427 | 4.76 | 0.000 | .5002577 | 1.201308 |
| cexp | .0003259 | .0001464 | 2.23 | 0.026 | .0000389 | .0006129 |
| feast | -1.020471 | .4155854 | -2.46 | 0.014 | -1.835004 | -.2059388 |
| infins | 3.053585 | .717233 | 4.26 | 0.000 | 1.647835 | 4.459336 |
| _cons | -8.977305 | 2.095351 | -4.28 | 0.000 | -13.08412 | -4.870493 |
| mills | | | | | | |
| lambda | -.0463946 | .0410924 | -1.13 | 0.259 | -.1269342 | .034145 |
| rho | -0.33335 | | | | | |
| sigma | .13917846 | | | | | |

# Annex E: Double-hurdle Model Estimation Result

```
. craggit commerc age sex edn fmsize frmsize freqext inf dst poffinc crdt fmlbr amount cexp feast infins, second(HCI age sex edn fmsize frmsize freqext inf dst poffinc crdt fmlbr amount ce
> xp feast infins) vce(robust)

                                                Number of obs     =        360
                                                Wald chi2(15)     =     118.90
Log pseudolikelihood =  133.63394               Prob > chi2       =     0.0000
```

| | Coef. | Robust Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| Tier1 | | | | | | |
| age | .0097866 | .013013 | 0.75 | 0.452 | -.0157183 | .0352916 |
| sex | -.1477733 | .2109326 | -0.70 | 0.484 | -.5611936 | .2656469 |
| edn | -.145312 | .1659821 | -0.88 | 0.381 | -.470631 | .180007 |
| fmsize | -.2696764 | .1064617 | -2.53 | 0.011 | -.4783376 | -.0610153 |
| frmsize | 1.575761 | .921269 | 1.71 | 0.087 | -.2298926 | 3.381416 |
| freqext | -.0284716 | .0328821 | -0.87 | 0.387 | -.0929192 | .0359761 |
| inf | .6341726 | .2969175 | 2.14 | 0.033 | .052225 | 1.21612 |
| dst | -.1982547 | .0433542 | -4.57 | 0.000 | -.2832273 | -.1132821 |
| poffinc | -.40194 | .2143087 | -1.88 | 0.061 | -.8219773 | .0180973 |
| crdt | .9971367 | .2525404 | 3.95 | 0.000 | .5021667 | 1.492107 |
| fmlbr | .5444708 | .1577231 | 3.45 | 0.001 | .2353392 | .8536023 |
| amount | .1509654 | .0696179 | 2.17 | 0.030 | .0145168 | .2874139 |
| cexp | -2.49e-06 | .0000502 | -0.05 | 0.960 | -.0001008 | .0000958 |
| feast | -.6676287 | .2173683 | -3.07 | 0.002 | -1.093663 | -.2415946 |
| infins | 1.480229 | .3571033 | 4.15 | 0.000 | .7803189 | 2.180138 |
| _cons | -2.083849 | .8824574 | -2.36 | 0.018 | -3.813434 | -.3542644 |
| Tier2 | | | | | | |
| age | .0007786 | .0008089 | 0.96 | 0.336 | -.0008069 | .0023641 |
| sex | -.0063832 | .0168548 | -0.38 | 0.705 | -.039418 | .0266516 |
| edn | -.0151637 | .0111372 | -1.36 | 0.173 | -.0369921 | .0066648 |
| fmsize | -.007892 | .0088301 | -0.89 | 0.371 | -.0251986 | .0094146 |
| frmsize | -.0397889 | .0463787 | -0.86 | 0.391 | -.1306896 | .0511118 |
| freqext | .001737 | .0012417 | 1.40 | 0.162 | -.0006967 | .0041708 |
| inf | .0709703 | .0308273 | 2.30 | 0.021 | .0105499 | .1313908 |
| dst | .0009948 | .0035888 | 0.28 | 0.782 | -.0060391 | .0080287 |
| poffinc | .0065459 | .0136163 | 0.48 | 0.631 | -.0201416 | .0332334 |
| crdt | -.0061825 | .0145619 | -0.42 | 0.671 | -.0347234 | .0223583 |
| fmlbr | -.0148168 | .0097722 | -1.52 | 0.129 | -.03397 | .0043364 |
| amount | .0264218 | .0023317 | 11.33 | 0.000 | .0218518 | .0309918 |
| cexp | 7.75e-06 | 2.70e-06 | 2.87 | 0.004 | 2.45e-06 | .0000131 |
| feast | -.0370981 | .0143154 | -2.59 | 0.010 | -.0651557 | -.0090404 |
| infins | .105623 | .040197 | 2.63 | 0.009 | .0268382 | .1844077 |
| _cons | .0561127 | .0680452 | 0.82 | 0.410 | -.0772534 | .1894787 |
| sigma | | | | | | |
| _cons | .1066841 | .0044075 | 24.20 | 0.000 | .0980455 | .1153227 |

# Annex F: Propensity Score Matching Model Estimation Result

```
. sum _pscore if commerc==1
```

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| _pscore | 278 | .9593357 | .13492 | .0090948 | 1 |

```
. sum _pscore if commerc==0
```

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| _pscore | 82 | .137862 | .2277349 | 3.68e-06 | .9067575 |

```
. sum _pscore
```

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| _pscore | 360 | .7722222 | .3804934 | 3.68e-06 | 1 |

## Matching algorithm

```
. psmatch2 commerc( age sex edn fmsize frmsize dst poffinc amount cexp feast infins freqext inf crdt fmlbr ), kernel outcome( income) bwidth(0.5) c
> ommon logit
```

| Variable | Sample | Treated | Controls | Difference | S.E. | T-stat |
|---|---|---|---|---|---|---|
| income | Unmatched | 30244.2446 | 20213.4146 | 10030.83 | 1362.42681 | 7.36 |
| | ATT | 20634.7826 | 19080.7071 | 1554.07552 | 2158.1691 | 0.72 |

Note: S.E. does not take into account that the propensity score is estimated.

| psmatch2: Treatment assignment | psmatch2: Common support Off suppo | On suppor | Total |
|---|---|---|---|
| Untreated | 0 | 82 | 82 |
| Treated | 255 | 23 | 278 |
| Total | 255 | 105 | 360 |

| Ps R2 | LR chi2 | p>chi2 | MeanBias | MedBias | B | R | %Var |
|---|---|---|---|---|---|---|---|
| 0.062 | 3.94 | 0.999 | 12.0 | 4.7 | 56.3* | 0.55 | 10 |

* if B>25%, R outside [0.5; 2]

```
. psmatch2 commerc( age sex edn fmsize frmsize dst poffinc amount cexp feast in
> fins freqext inf crdt fmlbr ), kernel outcome( income) bwidth(0.3) common log
> it
```

```
------------------------------------------------------------------------------
> ----------
        Variable     Sample |    Treated     Controls   Difference         S.E.
>    T-stat
-------------+----------------------------------------------------------------
> ----------
          income  Unmatched | 30244.2446   20213.4146     10030.83   1362.42681
>      7.36
                        ATT | 20634.7826   19011.5899   1623.19274   2438.01031
>      0.67
-------------+----------------------------------------------------------------
> ----------
Note: S.E. does not take into account that the propensity score is estimated.
```

| psmatch2: Treatment assignment | psmatch2: Common support Off suppo | On suppor | Total |
|---|---|---|---|
| Untreated | 0 | 82 | 82 |
| Treated | 255 | 23 | 278 |
| Total | 255 | 105 | 360 |

| Ps R2 | LR chi2 | p>chi2 | MeanBias | MedBias | B | R | %Var |
|---|---|---|---|---|---|---|---|
| 0.057 | 3.62 | 0.999 | 11.2 | 6.3 | 55.7* | 0.93 | 10 |

* if B>25%, R outside [0.5; 2]

```
. psmatch2 commerc( age sex edn fmsize frmsize dst poffinc amount cexp feast in
> fins freqext inf crdt fmlbr ), kernel outcome( income) bwidth(0.3) common log
> it
------------------------------------------------------------------------------
> ----------
        Variable     Sample |    Treated     Controls   Difference         S.E.
>    T-stat
-------------+----------------------------------------------------------------
> ----------
          income  Unmatched | 30244.2446   20213.4146     10030.83   1362.42681
>      7.36
                        ATT | 20634.7826   19011.5899   1623.19274   2438.01031
>      0.67
-------------+----------------------------------------------------------------
> ----------
Note: S.E. does not take into account that the propensity score is estimated.
```

| psmatch2: Treatment assignment | psmatch2: Common support Off suppo | On suppor | Total |
|---|---|---|---|
| Untreated | 0 | 82 | 82 |
| Treated | 255 | 23 | 278 |
| Total | 255 | 105 | 360 |

| Ps R2 | LR chi2 | p>chi2 | MeanBias | MedBias | B | R | %Var |
|---|---|---|---|---|---|---|---|
| 0.057 | 3.62 | 0.999 | 11.2 | 6.3 | 55.7* | 0.93 | 10 |

* if B>25%, R outside [0.5; 2]

```
. psmatch2 commerc( age sex edn fmsize frmsize dst poffinc amount cexp feast in
> fins freqext inf crdt fmlbr ), kernel outcome( income) bwidth(0.25) common lo
> git
```

| Variable | Sample | Treated | Controls | Difference | S.E. | T-stat |
|---|---|---|---|---|---|---|
| income | Unmatched | 30244.2446 | 20213.4146 | 10030.83 | 1362.42681 | 7.36 |
| | ATT | 20634.7826 | 18976.3009 | 1658.48172 | 2499.84572 | 0.66 |

Note: S.E. does not take into account that the propensity score is estimated.

| psmatch2: Treatment assignment | psmatch2: Common support Off suppo | On suppor | Total |
|---|---|---|---|
| Untreated | 0 | 82 | 82 |
| Treated | 255 | 23 | 278 |
| Total | 255 | 105 | 360 |

| Ps R2 | LR chi2 | p>chi2 | MeanBias | MedBias | B | R | %Var |
|---|---|---|---|---|---|---|---|
| 0.061 | 3.88 | 0.999 | 11.0 | 6.2 | 58.2* | 0.96 | 10 |

* if B>25%, R outside [0.5; 2]

```
. psmatch2 commerc( age sex edn fmsize frmsize dst poffinc amount cexp feast in
> fins freqext inf crdt fmlbr ), kernel outcome( income) bwidth(0.1) common log
> it
```

```
------------------------------------------------------------------------------
> ----------
    Variable     Sample |    Treated     Controls   Difference         S.E.
>    T-stat
-------------------------+----------------------------------------------------
> ----------
      income  Unmatched | 30244.2446   20213.4146     10030.83   1362.42681
>      7.36
                     ATT | 20634.7826   18640.2782   1994.50436   2547.23906
>      0.78
-------------------------+----------------------------------------------------
> ----------
Note: S.E. does not take into account that the propensity score is estimated.

 psmatch2:  |   psmatch2: Common
 Treatment  |        support
assignment  | Off suppo  On suppor |     Total
------------+----------------------+----------
 Untreated  |         0         82 |        82
   Treated  |       255         23 |       278
------------+----------------------+----------
     Total  |       255        105 |       360

------------------------------------------------------------------------------
Ps R2    LR chi2    p>chi2    MeanBias    MedBias      B        R      %Var
-------------------------------------------------------------------------------
0.079       5.02     0.996      11.2       11.9       66.6*     1.29      20
-------------------------------------------------------------------------------
* if B>25%, R outside [0.5; 2]

. psmatch2 commerc( age sex edn fmsize frmsize dst poffinc amount cexp feast in
> fins freqext inf crdt fmlbr ), kernel outcome( income) bwidth(0.08) common lo
> git

------------------------------------------------------------------------------
> ----------
    Variable     Sample |    Treated     Controls   Difference         S.E.
>    T-stat
-------------------------+----------------------------------------------------
> ----------
      income  Unmatched | 30244.2446   20213.4146     10030.83   1362.42681
>      7.36
                     ATT | 20634.7826   18384.4986   2250.28398   2726.10501
>      0.83
-------------------------+----------------------------------------------------
> ----------
Note: S.E. does not take into account that the propensity score is estimated.

 psmatch2:  |   psmatch2: Common
 Treatment  |        support
assignment  | Off suppo  On suppor |     Total
------------+----------------------+----------
 Untreated  |         0         82 |        82
   Treated  |       255         23 |       278
------------+----------------------+----------
     Total  |       255        105 |       360
```

```
------------------------------------------------------------------------------
Ps R2   LR chi2   p>chi2   MeanBias   MedBias      B       R      %Var
------------------------------------------------------------------------------
0.104      6.60    0.980      13.1      13.8      76.8*   1.18      20
------------------------------------------------------------------------------
* if B>25%, R outside [0.5; 2]

. psmatch2 commerc( age sex edn fmsize frmsize dst poffinc amount cexp feast in
> fins freqext inf crdt fmlbr ), outcome( income) neighbor(1) common logit

------------------------------+-----------------------------------------------
> ----------
        Variable     Sample |    Treated     Controls   Difference         S.E.
>    T-stat
------------------------------+-----------------------------------------------
> ----------
          income  Unmatched | 30244.2446   20213.4146     10030.83   1362.42681
>      7.36
                        ATT | 20634.7826   18969.5652   1665.21739   2854.96224
>      0.58
------------------------------+-----------------------------------------------
> ----------
Note: S.E. does not take into account that the propensity score is estimated.

 psmatch2:  |   psmatch2: Common
 Treatment  |        support
assignment  | Off suppo  On suppor |     Total
------------+----------------------+----------
 Untreated  |         0         82 |        82
   Treated  |       255         23 |       278
------------+----------------------+----------
     Total  |       255        105 |       360

------------------------------------------------------------------------------
Ps R2   LR chi2   p>chi2   MeanBias   MedBias      B       R      %Var
------------------------------------------------------------------------------
0.206     13.14    0.663      17.0      17.2     109.1*   2.18*     30
------------------------------------------------------------------------------
* if B>25%, R outside [0.5; 2]

. psmatch2 commerc( age sex edn fmsize frmsize dst poffinc amount cexp feast in
> fins freqext inf crdt fmlbr ), outcome( income) neighbor(3) common logit
```

```
------------------------------+-----------------------------------------------------------
> ----------
        Variable     Sample |    Treated     Controls   Difference         S.E.
>    T-stat
------------------------------+-----------------------------------------------------------
> ----------
          income  Unmatched | 30244.2446   20213.4146     10030.83   1362.42681
>      7.36
                         ATT | 20634.7826   19169.5652   1465.21739    2334.1951
>      0.63
------------------------------+-----------------------------------------------------------
> ----------
Note: S.E. does not take into account that the propensity score is estimated.
```

| psmatch2: Treatment assignment | psmatch2: Common support Off suppo | On suppor | Total |
|---|---|---|---|
| Untreated | 0 | 82 | 82 |
| Treated | 255 | 23 | 278 |
| Total | 255 | 105 | 360 |

```
-------------------------------------------------------------------------------
Ps R2    LR chi2    p>chi2   MeanBias   MedBias      B       R      %Var
-------------------------------------------------------------------------------
0.106       6.77    0.977      12.0       9.5      78.4*    1.64      20
-------------------------------------------------------------------------------
* if B>25%, R outside [0.5; 2]
```

```
. psmatch2 commerc( age sex edn fmsize frmsize dst poffinc amount cexp feast in
> fins freqext inf crdt fmlbr ), outcome( income) neighbor(5) common logit
------------------------------+-----------------------------------------------------------
> ----------
        Variable     Sample |    Treated     Controls   Difference         S.E.
>    T-stat
------------------------------+-----------------------------------------------------------
> ----------
          income  Unmatched | 30244.2446   20213.4146     10030.83   1362.42681
>      7.36
                         ATT | 20634.7826   19562.6087   1072.17391   2148.96299
>      0.50
------------------------------+-----------------------------------------------------------
> ----------
Note: S.E. does not take into account that the propensity score is estimated.
```

| psmatch2: Treatment assignment | psmatch2: Common support Off suppo | On suppor | Total |
|---|---|---|---|
| Untreated | 0 | 82 | 82 |
| Treated | 255 | 23 | 278 |
| Total | 255 | 105 | 360 |

| Ps R2 | LR chi2 | p>chi2 | MeanBias | MedBias | B | R | %Var |
|---|---|---|---|---|---|---|---|
| 0.077 | 4.92 | 0.996 | 12.5 | 8.0 | 65.8* | 1.43 | 10 |

* if B>25%, R outside [0.5; 2]

* if B>25%, R outside [0.5; 2]

```
. psmatch2 commerc( age sex edn fmsize frmsize dst poffinc amount cexp feast in
> fins freqext inf crdt fmlbr ), outcome( income) caliper(0.01) common logit
```

| Variable | Sample | Treated | Controls | Difference | S.E. | T-stat |
|---|---|---|---|---|---|---|
| income | Unmatched | 30244.2446 | 20213.4146 | 10030.83 | 1362.42681 | 7.36 |
| | ATT | 22588.8889 | 19788.8889 | 2800 | 3899.20655 | 0.72 |

Note: S.E. does not take into account that the propensity score is estimated.

| psmatch2: Treatment assignment | psmatch2: Common support | | |
|---|---|---|---|
| | Off suppo | On suppor | Total |
| Untreated | 0 | 82 | 82 |
| Treated | 269 | 9 | 278 |
| Total | 269 | 91 | 360 |

| Ps R2 | LR chi2 | p>chi2 | MeanBias | MedBias | B | R | %Var |
|---|---|---|---|---|---|---|---|
| 1.000 | 20.19 | . | 16.0 | 11.4 | 1.3e+15* | 0.52 | 10 |

* if B>25%, R outside [0.5; 2]

```
. psmatch2 commerc( age sex edn fmsize frmsize dst poffinc amount cexp feast in
> fins freqext inf crdt fmlbr ), outcome( income) caliper(0.05) common logit
```

```
------------------------------+-----------------------------------------------------------
> ----------
        Variable     Sample |    Treated     Controls   Difference         S.E.
>    T-stat
------------------------------+-----------------------------------------------------------
> ----------
          income  Unmatched | 30244.2446   20213.4146     10030.83   1362.42681
>      7.36
                         ATT | 21683.3333   19516.6667   2166.66667   2904.51126
>      0.75
------------------------------+-----------------------------------------------------------
> ----------
Note: S.E. does not take into account that the propensity score is estimated.
```

| psmatch2: Treatment assignment | psmatch2: Common support Off suppo | On suppor | Total |
|---|---|---|---|
| Untreated | 0 | 82 | 82 |
| Treated | 260 | 18 | 278 |
| Total | 260 | 100 | 360 |

```
-----------------------------------------------------------------------------
Ps R2    LR chi2    p>chi2   MeanBias   MedBias      B        R      %Var
-----------------------------------------------------------------------------
0.271      13.52     0.635      19.2      14.7     125.9*    3.04*     20
-----------------------------------------------------------------------------
* if B>25%, R outside [0.5; 2]

. psmatch2 commerc( age sex edn fmsize frmsize dst poffinc amount cexp feast in
> fins freqext inf crdt fmlbr ), outcome( income) caliper(0.1) common logit
------------------------------+-----------------------------------------------------------
> ----------
        Variable     Sample |    Treated     Controls   Difference         S.E.
>    T-stat
------------------------------+-----------------------------------------------------------
> ----------
          income  Unmatched | 30244.2446   20213.4146     10030.83   1362.42681
>      7.36
                         ATT | 20634.7826   18969.5652   1665.21739   2854.96224
>      0.58
------------------------------+-----------------------------------------------------------
> ----------
Note: S.E. does not take into account that the propensity score is estimated.
```

| psmatch2: Treatment assignment | psmatch2: Common support Off suppo | On suppor | Total |
|---|---|---|---|
| Untreated | 0 | 82 | 82 |
| Treated | 255 | 23 | 278 |
| Total | 255 | 105 | 360 |

| Ps R2 | LR chi2 | p>chi2 | MeanBias | MedBias | B | R | %Var |
|---|---|---|---|---|---|---|---|
| 0.206 | 13.14 | 0.663 | 17.0 | 17.2 | 109.1* | 2.18* | 30 |

* if B>25%, R outside [0.5; 2]

## Annex G: Balancing criteria

| Sample | Ps R2 | LR chi2 | p>chi2 | MeanBias | MedBias | B | R | %Var |
|---|---|---|---|---|---|---|---|---|
| Unmatched | 0.822 | 317.70 | 0.000 | 88.0 | 49.5 | 258.2* | 7.80* | 80 |
| Matched | 0.057 | 3.62 | 0.999 | 11.2 | 6.3 | 55.7* | 0.93 | 10 |

* if B>25%, R outside [0.5; 2]

## Annex H: Average treatment effects

| Variable | Sample | Treated | Controls | Difference | S.E. | T-stat |
|---|---|---|---|---|---|---|
| income | Unmatched | 30244.2446 | 20213.4146 | 10030.83 | 1362.42681 | 7.36 |
| | ATT | 20634.7826 | 18986.9044 | 1647.87819 | 2405.80889 | 0.68 |
| | ATU | 19816.6667 | 17232.3842 | -2584.28246 | . | . |
| | ATE | | | -1213.30084 | . | . |

Note: S.E. does not take into account that the propensity score is estimated.

## Annex I: Boost strapped standard error

```
. bs"psmatch2 commerc( age sex edn fmsize frmsize dst poffinc amount cexp feast infins freqex
> t inf crdt fmlbr ),outcome( income) "r(att)", r(100)

command:      psmatch2 commerc( age sex edn fmsize frmsize dst poffinc amount cexp feast infi
> ns freqext inf crdt fmlbr ) , outcome( income)
statistic:    _bs_1      = r(att)
note: label truncated to 80 characters

Bootstrap statistics                              Number of obs    =       360
                                                  Replications     =       100
```

| Variable | Reps | Observed | Bias | Std. Err. | [95% Conf. | Interval] | |
|---|---|---|---|---|---|---|---|
| _bs_1 | 99 | 19434.53 | -5379.958 | 5386.116 | 8745.961 | 30123.11 | (N) |
| | | | | | 3787.839 | 20594.77 | (P) |
| | | | | | 13780.59 | 21392.65 | (BC) |

```
Note:  N   = normal
       P   = percentile
       BC  = bias-corrected
```

## Annex J: Sensitivity test

```
. rbounds income , gamma(1(.25)3)

Rosenbaum bounds for income (N = 360 matched pairs)
```

| Gamma | sig+ | sig- | t-hat+ | t-hat- | CI+ | CI- |
|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 27500 | 27500 | 26000 | 28650 |
| 1.25 | 0 | 0 | 26000 | 28500 | 25000 | 30000 |
| 1.5 | 0 | 0 | 25000 | 29500 | 24000 | 31000 |
| 1.75 | 0 | 0 | 24500 | 30500 | 23000 | 31850 |
| 2 | 0 | 0 | 23700 | 31000 | 22500 | 32500 |
| 2.25 | 0 | 0 | 23000 | 31750 | 22000 | 33350 |
| 2.5 | 0 | 0 | 22500 | 32500 | 21500 | 34000 |
| 2.75 | 0 | 0 | 22250 | 33000 | 21000 | 34500 |
| 3 | 0 | 0 | 22000 | 33500 | 20500 | 35000 |

```
* gamma  - log odds of differential assignment due to unobserved factors
  sig+   - upper bound significance level
  sig-   - lower bound significance level
  t-hat+ - upper bound Hodges-Lehmann point estimate
  t-hat- - lower bound Hodges-Lehmann point estimate
  CI+    - upper bound confidence interval (a=  .95)
  CI-    - lower bound confidence interval (a=  .95)
```